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(Revised June 16, 1915.)

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SIDNEY WILLETT HOAG, JR., PRESIDENT

1912

THE MUNICIPAL ENGINEERS OF THE CITY OF NEW YORK

PROCEEDINGS

FOR

1912

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CONTENTS.

PROCEEDINGS OF THE MUNICIPAL ENGINEERS OF THE CITY OF NEW YORK.

PAPER No. 70.—MUNICIPAL PROBLEMS OF TERMINAL FREIGHT TRANSFERENCE. BY H. McL. HARDING, CONSULTING ENGINEER, DEPARTMENT OF DOCKS, NEW YORK CITY.......... 5

PAPER No. 71.—DRAFTING METHODS OF THE BOARD OF WATER SUPPLY. BY CLARENCE F. BELL, M. M. E. N. Y., ASSISTANT ENGINEER, BOARD OF WATER SUPPLY.......... 29

PAPER No. 72.—PROGRESS OF THE CITY TUNNEL OF THE CATSKILL AQUEDUCT, BOARD OF WATER SUPPLY. BY WALTER E. SPEAR, M. M. E. N. Y., DEPARTMENT ENGINEER, BOARD OF WATER SUPPLY.......... 62

PAPER No. 73.—THE STORY OF THE "MAINE." BY WILLIAM M. BLACK, COLONEL, CORPS OF ENGINEERS, UNITED STATES ARMY.......... 100

PAPER No. 74.—THE SEGREGATED BUDGET AS APPLIED TO MUNICIPAL ENGINEERING WORK. BY FRED. W. LINDARS, CERTIFIED PUBLIC ACCOUNTANT WITH THE BUREAU OF MUNICIPAL RESEARCH.......... 129

PAPER No. 75.—THE FOURTH AVENUE SUBWAY, BROOKLYN. BY H. L. OESTREICH, M. M. E. N. Y., SENIOR ASSISTANT DIVISION ENGINEER, PUBLIC SERVICE COMMISSION.......... 162

PAPER No. 76.—A HISTORY OF THE TAXATION OF REAL ESTATE AND THE TAX MAPS OF THE CITY OF NEW YORK. BY HENRY W. VOGEL, M. M. E. N. Y., SURVEYOR, DEPARTMENT OF TAXES AND ASSESSMENTS.......... 221

PAPER No. 77.—THE PARKS OF NEW YORK CITY CONSIDERED FROM A PROFESSIONAL STANDPOINT. BY CHARLES DOWNING LAY, M. M. E. N. Y., LANDSCAPE ARCHITECT, DEPARTMENT OF PARKS.......... 256

ANNUAL ADDRESS OF THE PRESIDENT.......... 276

ANNUAL DINNER.......... 325

INSPECTIONS.......... 341

MEMOIRS OF DECEASED MEMBERS.......... 343

INFORMATION RELATING TO THE SOCIETY.......... 349

OFFICERS AND COMMITTEES FOR 1912.......... 350

OFFICERS AND COMMITTEES FOR 1913.......... 352

PAST AND PRESENT OFFICERS.......... 354

AWARD OF PRIZES AND PAST-PRESIDENTS' MEDALS.......... 356

INDEX TO PREVIOUS VOLUMES OF PROCEEDINGS.......... 357

INDEX TO ADVERTISERS.......... 1

THE MUNICIPAL ENGINEERS OF THE CITY OF NEW YORK.

Paper No. 70

PRESENTED FEBRUARY 28, 1912.

MUNICIPAL PROBLEMS OF TERMINAL FREIGHT TRANSFERENCE.

BY H. McL. HARDING.*

WITH DISCUSSION BY
SIDNEY W. HOAG, JR., R. P. BOLTON, PERCY C. BARNEY AND H. McL. HARDING.

Freight terminals and the operating conditions whereby there can be rapid and economical transference of miscellaneous freight have not until recently been a matter of moment to municipal engineers. A freight terminal, whether for rail or water-borne freight, formerly came within the province of the railway engineer and the steamship superintendent. In the United States, cities in the past have had little if any ownership in their water-fronts. The wharves, piers and bulkheads, and the structures upon them belonged either to private owners, to steamship companies or later to the railways. That a city should have any control over a railway terminal, even though correlated with a water terminal, is to-day almost an anomaly in this country, although such combined terminals at the larger foreign ports are under the jurisdiction of public authority. There are a few similar ports in this country.

Public opinion was dormant as to terminals, their importance and their equipment, until the increasing cost of freight transportation became a vital factor in the cost of living, and now the cities are realizing that transportation efficiency is a terminal problem, and that the transportation expense forms a large part of the cost of what we eat and wear.

* Consulting Engineer, Department of Docks, New York City.

Within the last few years there has been such a change of sentiment, especially regarding the water terminals, that the cities are expropriating these water gateways, and now their development, improvement and operation form an important feature in city government, and there is opened to municipal engineers a new field of activities for which there should be a most satisfactory recompense.

The following quotation from the report of the Montreal Harbor Commission gives emphasis to the above in connection with the design of terminals and construction work by the engineers.

"The engineering profession through the importance placed upon its integrity and high standing, the remuneration it commands, has attracted to it men of commanding ability and executive skill. They study not only the technical features but they qualify themselves for expert executive advice and take a prominent part in the councils of commercial and corporation boards."

Therefore among the duties of municipal engineers will now be those which call for a study of the direction of traffic and transportation, that is the freight movements, and the location of such docks and terminals as may be essential to the growth and progress of a city.

For the improvement of any individual city, there should be a knowledge of railway terminals, water terminals, the water frontage, sites for docks and industrial manufacturing, warehouse location and other features of the whole terminal, and a study of how these can be so co-ordinated as to secure the best results, and how the elements of the terminal should be placed relative to each other.

This correlation of the limbs of a terminal forms an essential part of the engineering work. Instead of suggesting special machines for this terminal transference, it seems best to lay emphasis on the conditions to be fulfilled by any machinery, and to leave the selection of the best to the engineer for any particular location.

Foreign Port Conditions.

From investigation of the conditions at important foreign ports, it was ascertained that the lowest cost of freight transference was where all the terminal elements were under one control, and that

PLATE 1.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
HARDING ON MUNICIPAL PROBLEMS
OF TERMINAL FREIGHT TRANSFERENCE.

CRANES ON WESTKAI. STETTIN, GERMANY.

CRANES ON OSTKAI.

a city was increasing in prosperity where its engineers planned and executed improvements in advance of actual needs, and that those cities which had not provided for the future were surpassed by those whose terminals were properly constructed and equipped.

Public Ownership.

New York was one of the first cities to purchase, in some cases to re-purchase, its water terminals. After securing possession, the City first leased the ground to transportation companies, then constructed and rented the piers and finally the sheds in addition. Now, following the example of foreign ports, it should supply mechanical equipment, so as to correlate the railway with the water terminals. All of this is in accordance with the best practice abroad, but an advance can be made in that all the elements of a terminal may be connected as one unit.

The problem for the City of New York has after many years of discussion (some twenty-four) been successfully solved under the skillful direction and by the almost superhuman efforts of the present Commissioner of Docks and Ferries, Mr. Calvin Tomkins, and his associates, and the adoption of his plans only awaits official sanction. Many other American cities and states are for the first time beginning to realize the intimate connection between the prosperity of a city and its terminal facilities.

The State of Massachusetts with the City of Boston, appreciating this, has already appropriated $9 000 000 for terminal improvements and equipment, of the $25 000 000, which, it is expected, will be the necessary expenditure. For Boston, there have been many plans designed and proposed, and those illustrated, even without the structures, will indicate the magnitude and importance of the work to be initiated and supervised by the municipal engineers.

The State of Connecticut has set aside as a beginning $1 000 000 for terminal facilities and mechanical appliances for the port of New London. Rhode Island, Providence, Baltimore and Philadelphia have expended large sums for piers, sheds and facilities, one of the later sheds at Philadelphia far exceeding in cost any along the North river water-front at the port of New York.

It would take too long to refer to the plans of many other cities such as Lynn, Mass., Norfolk, Va., Savannah, Ga., Charleston, S. C., Mobile, Ala., Galveston and Texas City. It may be said, however, that all of these cities and others have the problems of terminal improvements before their municipal engineers. At New Orleans, of the water-front, the city has about 6 miles of public owned wharves, twenty-five in number and about fifteen large steel sheds and warehouses. A municipal committee has built and operates a belt railway with its terminals along the entire water-front, 10 miles in length, with about forty industrial sidings or spurs. The main track will be extended to nearly 22 miles.

At San Francisco, the entire water frontage, the wharves and belt line, are owned by the public authority and under the control of the harbor commission and the municipal engineers. There is the same intense interest manifested at Los Angeles, Seattle and Tacoma. Oregon has established the so-called ports such as the Port of Portland, the Port of Astoria and others which are in reality improved water-districts.

In the Mississippi Valley, St. Paul, Minn., Burlington, Iowa, Alton, Ill., St. Louis and all the cities to the Gulf are also considering extensive terminal improvements. The millions spent by the Government on the channels are in addition to that expended by the states and cities, but the latter must do their part before other large appropriations will be made by the Government.

The great problem to be solved by the municipal engineers is the rapid and easy transference of miscellaneous freight with the least friction between all the elements of a complete terminal and the transporting factors. All the elements must be mechanically articulated or correlated.

Factors and Terminal Elements.

The factors and terminal elements consist of the vessel, the pier, the pier shed, the bulkhead and bulkhead shed, slips or docks, quays, the railway cars, tracks and platforms, the dray-areas and platforms, the warehouses and warehouse space, and in some cases local industries. At some ports, basins for discharging lumber should also be included. The vessel-factors comprise ocean liners, coastwise steamships, tramp steamships, lighters, barges and canal boats.

10-Ton Crane.

Favorite Type of Gantry Crane.

The pier and bulkhead should be completely or partially shedded. The sheds and railway stations may be of one or more stories, depending upon the available room and the character of the freight. One story is generally preferred. The cars, car tracks and platforms should be located where they will not interfere with freight movements, where there is the least hand-trucking, and where they will be readily accessible for the loading and discharging of the freight. The dray-areas and platforms should be arranged so that there will not be congestion, either of the drays or their loads, and also ample room for the dray service and for the delivery and receiving platforms. While the sheds are only for the temporary holding of the freight, the warehouses should have ample space for as long storage as may be desired. The position of each, in relation to each other, must necessarily vary, but with projecting piers for package freight, the car-tracks should be to the rear of the piers and at right angles to them.

The warehouses should always be at the rear of the piers, but so placed that there can be a free transport between the pier and the warehouse, and that they also be connected with the railways and drays without interfering with the important conveying movements between the other elements. Warehouse areas, including approaches, and yards for cars and drays, are essential.

Lighters and Canal Barges.

All the terminal elements should be so planned as to provide for lighter and barge service the same as for steamships.

There is a world-wide agitation for improving waterways, especially the canals, therefore provision should be made for canal-barge terminals. Here the problem consists, for a given frontage, of being able to berth at one time the greatest possible number of barges, to load and unload them quickly without congestion or interference with each other, to provide rail, dray and harbor barge or lighter connections, and—this should receive equal attention—to see that there should also be a large temporary, safe and weather-protected storage capacity. The slips, docks and other water areas, should be proportioned to the volume of the freight.

Where the water areas are restricted so that there cannot be jutting piers, quays with walls parallel to the shore, sheds at right

angles to the quay walls, the fronts distant about 20 ft. from the quay edge and the railway tracks passing through the rear of the sheds at right angles to their length, are recommended. This arrangement can be made most efficient when long-distance transferring machinery is installed. The above is from the standpoint of mechanical transference.

Freight Movements.

The following are the direct freight movements, both inbound and outbound: Between vessel and pier and shed, vessel and bulkhead, quay and shed, vessel and cars and car platforms, vessel and dray-areas and platforms, vessel and warehouses, vessel and lighters, barges, canal boats and other ships. These may be called the principal movements, but there are secondary movements equally important, such as between the different sections of a pier, the pier sheds and cars, drays and warehouses, or between any other one element and another.

From a study of these movements it becomes evident that freight transference at water terminals, is not merely the swinging of the freight between the vessel and the pier side or quay wall, but the more important linking together in many diverse ways of all the elements including assorting and distribution. Often the distance between the factors and elements or between the different elements may be several thousand feet.

To show the relative importance of two movements, it costs about three cents per ton to swing from the hold of the vessel to the side of the pier, but about thirty cents additional to assort and to distribute upon the pier, and from twenty to thirty cents more, if there is another movement between the pier and the warehouse, the expense varying with the distance. This latter service is generally performed by lorries, a form of horse truck or power trucks of different types. Of the two latter methods, that known as the trackless trolley has been employed successfully in Austria and shows the lowest maintenance expense for surface trucking.

The properly connecting by transferring machinery all these factors and terminal elements is becoming the distinguishing feature between modern terminals and those of the past. The terminal element comprising the cars, tracks and platforms, constitute in ef-

PLATE 3.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
HARDING ON MUNICIPAL PROBLEMS
OF TERMINAL FREIGHT TRANSFERENCE.

Sheds at Right Angles to the Quay Walls. Full Arch Gantry. Antwerp.

Ship's Winch. Open Hatchways. New York.

An Example of Pier Congestion. Small Dray Area. Capacity Could be Increased by Higher Tiering. A New Shed Should Have More Vertical Room.

Structural Steel Congesting Floor Space. No Opportunity for Floor Surface Conveying. Ample Room Overhead. Many Cranes are Necessary, but even then there is not Secured Continuous Rapidity.

fect an outbound and inbound railway freight station, as here are often performed all the functions of such a railway terminal.

For any terminal, steamship or railway, to be successful, that is, to attain rapidity and economy, there must be freedom for all these interconnecting freight movements without interferrence or congestion.

Principles and Rules for Freight Transference.

It is necessary that there should be principles or rules which should be the touchstone, whereby any hoisting and conveying mechanism for package freight can be tested and judged, and its comparative operative value determined.

By having such rules and proving their correctness, there is a confidence in giving a prompt decision as to the practicability of any device submitted or referred to engineers, which decision without some such authority, would be more or less difficult. These rules represent the practical experience of many railway engineers and operating superintendents of transportation companies, and are based upon letters from them in response to inquiries.

There will be many such mechanical devices for freight handling presented and in regard to which an opinion may be desired, and to these the following principles can be applied:

1st. That the machinery should be able to serve directly and economically all space, not only floor space, but also cubical space, that is, high tiering.

2nd. That there should be no rehandling by manual labor. That is, one part of the work should not be accomplished by machinery and another part by man. (This does not mean the first handling, but rehandling.)

3rd. That there should be continuous rapidity. The movement of hoisting and conveying should be quickly followed by a similar movement without delay. This result can only be attained by having the movements form a complete circuit.

If any device will not fulfill these three conditions, it should be ascertained how many it will accomplish and its comparative value be thus determined.

The following are a few of the different types of freight-handling

mechanisms to which, for the purpose of illustration, the rules will now be applied:

These are the travelling shop crane, moving floor platforms, slot conveyors, belt conveyors, ramps, movable-floor platform conveyors, transporters, lorries, motor-trucks, fixed jib cranes, horizontal movable jib cranes attached to travelling shop cranes, locomotive cranes, ship and dock winches and the travelling gantry cranes of the half and full arch type. These are all excellent machines for specific work and are extensively used.

As to the travelling shop crane, first, this will fulfill the first condition, it will serve all space including tiering, raising and lowering loads anywhere within the range of its side tracks; second, no rehandling by manual labor is necessary, as with the fixed overhead tracks; third, there is not, however, continuous rapidity, for while the crane is travelling to the end of the space served, and returning, the men receiving the loads or attaching will be idle. In freight movements, rapidity of transference is often of more value than economy of operation, therefore, shop cranes are not employed in the rapid movements of freight transference, although they have been used to a limited extent at a terminal at Texas City. If the travelling crane could fulfill the last condition of continuous rapidity it would be the ideal mechanism.

Applying the rules to moving floor platforms, slot conveyors and belt conveyors, these may fulfill the third condition of continuous rapidity, but for package freight, they do not serve all space or tier, and, furtherfore, require much rehandling both for placing upon and removing from the conveyors. Movable inclined conveyors can raise loads, or tier, and will give continuous rapidity, but will not serve floor space, especially at the upper end of the conveyor, while much labor is required to avoid congestion at the receiving and delivery ends.

As rehandling adds at least 50% to the original cost of handling, and generally more, the necessity for avoiding this is self-evident. These machines also occupy valuable floor space. They can be used to great advantage in certain localities for certain kinds of freight.

Ramps, for raising loads between different floors, fail in respect to the first and second conditions, but to a limited degree succeed with the third. They have a special use.

PLATE 5.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
HARDING ON MUNICIPAL PROBLEMS
OF TERMINAL FREIGHT TRANSFERENCE.

A Transporter. Useful in Many Respects but does not Serve Space with Continuous Rapidity.

Handling Bulk Freight. It Lifts Fifteen Tons in One Load.

A Combination of Bridge Crane of the Gantry Type with an Overhead Locomotive Crane.

An Automatic Telfer with Device for Opening Doors.

Hoisting transporters, if the overhead runway is in the form of a continuous loop, give continuous rapidity, but cannot serve broad areas and there is also rehandling.

Fixed jib cranes will serve a limited cubical space, but outside of this space there is required rehandling, and there is a failure in respect to continuous rapidity. Locomotive cranes increase the space area of the fixed jib crane, but rehandling is still required, and this type is limited in regard to continuous rapidity. To secure speed, a number of these cranes should be operated within a small area. They occupy of themselves valuable floor space during operation and for travelling. The ship winch is a form of stationary jib crane, the swinging boom constituting the jib. They are exceedingly valuable for a limited range, and the winchmen often become exceedingly proficient.

The travelling gantry crane in its operation is similar to the locomotive crane, but is far superior in being elevated and occupying little floor space. To obtain anything like continuous rapidity, many such cranes are installed at foreign ports along the quay wall as close to one another as possible without the jibs interfering. Often one leg only moves along the quay wall, the other being at right angles to the first travels along an elevated rail attached to the roof or side of the shed. Of all the older types, the gantry crane has been the one chiefly adopted for seaports, the same as the travelling cross-crane has been the universal type for machine shops.

The horse truck (lorry) and the motor truck will serve floor space but not cubical space, will not tier and will not directly transfer between floors; they require rehandling in the unloading and where the load is placed upon the motor truck and not upon trailers continuous rapidity is lacking, and as the transporting unit must wait for the loading and the unloading, besides requiring much floor area, there is produced congestion upon the pier floor.

There might be mentioned other principles but it seemed best to condense all into three, so that their application could be easily made to any type of package freight transferring machinery.

Designing of New Terminals.

To attain the best results for all these freight movements in their perfection, any new terminal should from its conception be designed and planned by the municipal engineer in charge, and if this is

done success will not be curtailed by limiting conditions. Furthermore, the machinery may be the best, both mechanical and electrical, but if not installed by engineers familiar with American operating conditions it will not be used. The truth of this has already been demonstrated.

TREND OF DEVELOPMENT.

A careful study of the types of machinery at the principal foreign ports and railway stations, and also of the improved mechanism lately produced by various manufacturers, indicate clearly what is the trend of the machinery development.

This consists almost entirely in increasing the range or distance covered by the various types of cranes or winches, and as there are still in operation some of the earliest and intermediate types, as well as of the latest period, the history and evolution can be readily traced.

In the beginning there was the fixed or stationary jib crane operated by man power, then the power jib or boom crane, followed by the surface travelling jib crane (locomotive type), then the elevated portable jib crane, either whole or half arch gantry, next the transporter, then the fixed overhead runway with travelling conveyors and hoists, and finally the combination of fixed and movable overhead runways and travelling winches or hoists.

The gantry types of cranes and winches, fixed and movable, aré placed sometimes on the pier or quay wall, often on the ship, sometimes upon the shed roofs, as at Bristol and Liverpool, attached to the side of the building or overhead under a projecting roof. The travelling runways are generally attached to the pier shed or railway station structure.

At many foreign ports and railway stations, types of cranes now recommended for American service were installed thirty years ago.

The problem of freight transference, as is evident from the diagram of freight movements, is not merely to swing from the ship's side upon the side of the pier, but to transfer the freight between all the different terminal elements. Between the vessel and pier is only one of many movements.

The ship or dock winch is stationary, but the travelling winch on overhead movable tracks will serve areas including tiering,

PLATE 7.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
HARDING ON MUNICIPAL PROBLEMS
OF TERMINAL FREIGHT TRANSFERENCE.

TERMINAL MOVEMENTS. BULK OR COAL CONVEYING AND HOISTING. THE TRACKAGE NOT BEING IN THE FORM OF A LOOP AND BEING FIXED, CANNOT GIVE CONTINUOUS RAPIDITY OR SERVE CUBICAL SPACE.

ONE OF THE EARLY TYPES OF OVERHEAD CONVEYORS AND HOISTS, OF ENGLISH MANUFACTURE, AND WAS INSTALLED FOR SUPPLYING THE SIDE BINS.

PLATE 8.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
HARDING ON MUNICIPAL PROBLEMS
OF TERMINAL FREIGHT TRANSFERENCE.

LONG DISTANCE TRANSFERENCE.

Side view of Telfer, trailers and three trucks loaded with cocoa bags. Capacity, 1 ton per minute in either direction, or 2 tons per minute if loads are carried in both directions, which would be at a cost of a fraction of a cent a ton for daily operating expenses. Located at Walter Baker Chocolate Works, Boston, Mass.

FREIGHT MOVEMENTS.

In this terminal it will be noticed that the service is limited to the sides of the building. It does not cover areas but only straight narrow sections. Too many cross tracks would be expensive.

whereby is obtained all the operating advantages of the winch with a much greater range.

Any machinery which will perform all these different movements under the conditions as enumerated would be the most suitable, otherwise that machine which will come nearest to fulfilling these conditions would be of the next value.

By having one combined mechanism transfer the freight directly and not requiring two machines to perform one movement, there is a saving in time, in labor and a freedom from loss and breakage.

From the machines mentioned, or from a modification of them, there should be selected that which will best fulfill the conditions, for it is evident that these are of varying degrees of excellence.

It may be asked, which one is the least expensive for first cost of machinery and installation? It would seem as though it would be difficult to compare mechanisms differing so widely. One method of comparison may be, which machine will cost the least per cubic foot of space served. If a machine can only serve by itself a space of a few cubic feet around the gangway on the side of a pier, its relative value can be easily ascertained in comparison with that one which will serve the whole pier shed, and the latter with one that will serve the pier, bulkhead, cars and warehouse areas.

If another machine can only serve floor space and not tier, its position in the column of efficiencies of different machines would not be very high. If one can serve floor space, but requires valuable floor area to be reserved for its freight conveying movements, then it has not the same value as one not requiring floor area. One that can only tier 5 ft. high will not compare favorably with one that can tier 10 ft., as 10 ft. tiering will require a station or pier shed of one-half the size of one tiering 5 ft.

In using as a basis for comparing first costs the number of cubic feet served, there can be established a flexible unit of volume and tonnage capacity.

In measuring package freight, it is better instead of taking the marine ton of 40 cu. ft. to substitute 60 cu. ft. as being more nearly correct. This figure is derived from the average number of cubic feet per ton of many miscellaneous articles.

As volume is more important than weight in determining the hoisting and conveying capacity of any machinery for package

freight, the cubic foot should be the unit of measuring for this class of freight and the ton unit be continued for bulk freight.

The first cost of an installation does not depend upon the machinery alone but is combined with the cost of the pier shed or station or other buildings or land. Other items can also be added.

As an example, the cost of the machinery, of the pier, shed and land, the shed being 750 ft. long, 125 ft. wide and 30 ft. high in the clear below the cross-girders, might be $350 000. The workable cubical contents, tiering twenty feet high, would be 1 875 000 cu. ft., and making allowances would have a capacity of about 23 000 tons, 60 cu. ft. being equal to one ton.

The cost of the machinery may be taken as $60 000.

The total cost per ton would be $\frac{350\,000}{23\,000}$ or $15.21. If the usual 5-ft. tiering with machinery costing $20 000 the cost per ton capacity would be about $53 per ton.

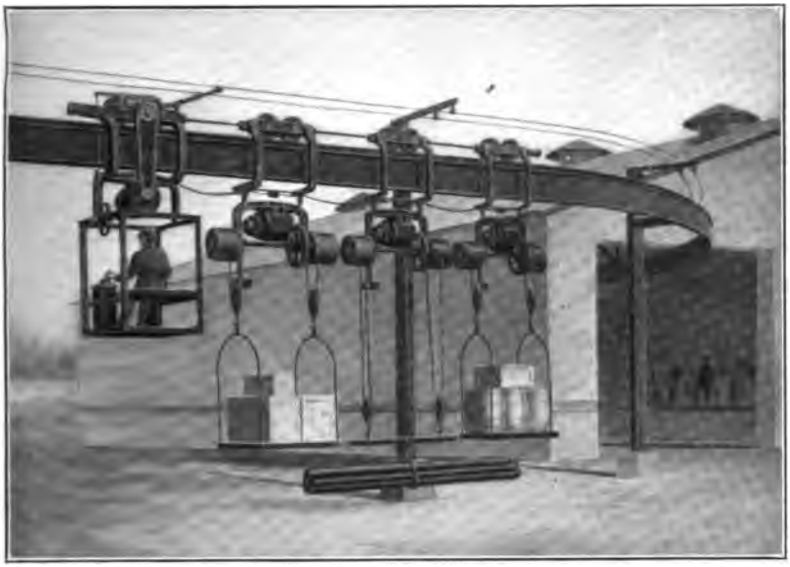
Suppose the machinery to be the hand or four-wheeled trucks and costing nothing, then the final cost, tiering 5 ft. high, would be about $50 per ton. By installing a machine which would tier 20 ft., the total first cost per ton handled would therefore be much less than one that could only tier 5 ft. A comparison in operating expenses between one that does not and one that does require rehandling at the end of the conveying trip is equally instructive.

Five feet is the average height of tiering by manual labor. To tier higher adds greatly to the expense of handling. Interest and amortization depend upon first cost, and therefore upon cubical capacity.

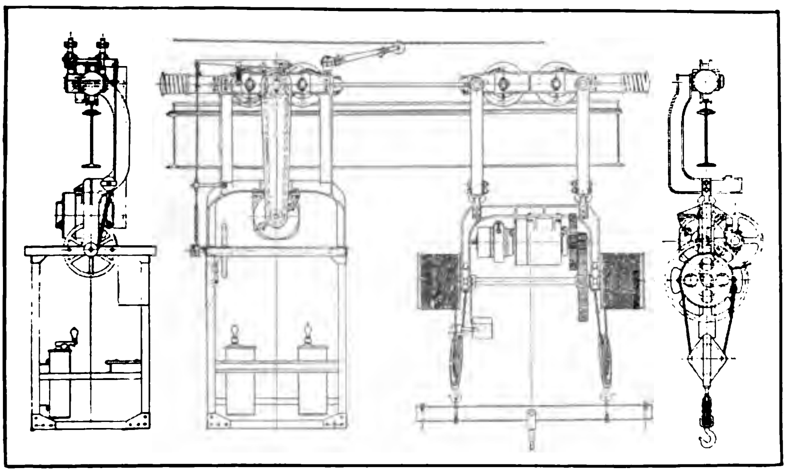
The cost of operation emphasizes many items, but labor, power and maintenance are the chief. It is customary to reduce these to a cost per ton transferred. The influence of cubical contents is even more significant in the operating expense than in the first cost.

That which limits the capacity of transference is not so much the tonnage as the volume or space occupied per load. Lighter-weight freight requires more trips than the heavier on account of space required on the flatboards. Each flatboard carrier is limited to about 6 ft. by 3 ft., in some cases to 7 by 3½ ft. A six by three flatboard will hold, on the average, about 90 cu. ft. of ordinary freight. This is only one and one-half tons, whereas two or three

PLATE 9.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
HARDING ON MUNICIPAL PROBLEMS
OF TERMINAL FREIGHT TRANSFERENCE.



TRANSFER AND TRAILERS. THE TRAILERS AND HOISTS ARE ALL CONTROLLED BY THE TRANSFERMAN.



ASSEMBLY SKETCH OF TRANSFER AND HOISTS. THE DETAILS OF THE MECHANISM INDICATE THE VARIOUS MECHANICAL MOVEMENTS.

Attention is called in this view to the supports along the side of the building for the fixed track upon which the cross tracks travel. These are thus constructed so as to allow the passage of the electric transfers along the side, after they have crossed by means of the moving cross track, which is equivalent to an ordinary travelling crane with a track attached. It will be noticed that there are two such cranes and together they form a circuit so that one or more transfers can pass over one, then along the side and across the other and return. The two cross tracks with the cranes are movable so that loads can be raised and lowered over every square foot of the floor space and tiered.

The upper view illustrates the travelling shop crane, while the lower depicts the travelling bridge and the loop gantry crane.

tons of less bulky weight could easily be carried on the flatboard. To reduce the labor cost per ton of this lighter freight, three trailers or flatboard loads are carried in a train, and the labor cost is reduced to about two-fifths. The power is electricity and can be purchased from existing power plants for four cents per kilowatt hour and upwards.

The maintenance costs should be figured as usual averaging 10% simple interest, being about double on the moving and hoisting machinery portion of the installation than on the trackage.

Assuming, as an example, the cost of hoisting and conveying by travelling winches or conveyor hoists over the average distances at terminals to be five cents for each sixty cubic feet of freight transferred, the details of the cost of operation would be:

Labor	15%	of	transference	costs.
Interest and amortization.	30%	"	"	"
Electricity	20%	"	"	"
Maintenance	20%	"	"	"
Incidentals	15%	"	"	"

The present average manual labor cost for inbound and outbound freight at railway or steamship terminals is about 35 cents per ton. The same work by mechanical methods is about 15 cents per ton, a saving by the latter method of 20 cents.

Where machinery replaces inefficient manual labor, the savings both direct and indirect are so great that any such machinery will pay for itself within two or three years. There are now leading manufacturers in the United States who will furnish excellent machinery for all terminal freight movements.

It may be said that the advantages of connecting the terminal units by mechanical methods consist in:

1st. The reducing of the time of transference by one-half in comparison with manual labor.

2nd. A saving effected of at least one-half, provided there is no rehandling.

3rd. A larger storage or holding capacity on piers due to high tiering and increased speed of loading and discharging cars and vessels.

4th. Fewer cars or vessels to transport a given tonnage due to less detention.

5th. Smaller port- or station-investment.

6th. Improved service for drays and reduction in damage claims for breakage.

There are also other economies which are the natural results of greater rapidity in these freight movements.

Finally, the municipal problem of freight transference consists in so locating all the terminal elements or limbs that they and the transporting factors can be properly articulated, both in relation to themselves and the needs of a city.

If this be in accordance with engineering advice, using mechanical methods, freight can be transferred quickly and economically between all the elements, including tiering, and this problem is solved.

PLATE 11.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
HARDING ON MUNICIPAL PROBLEMS
OF TERMINAL FREIGHT TRANSFERENCE.

TRANSFER TRACTOR AND TRAILERS.

DISCUSSION.

Sidney W. Hoag, Jr., M. M. E. N. Y.—Mr. Harding, in operating this loop system, the motion, I take it, is always in one direction, like the hands of a clock, for instance. In the case of operating a machine that happens to be standing still, picking up a load, and another one approaches the same tangent from another loop, what happens when it overtakes the one standing still?

Mr. H. McL. Harding.—In handling miscellaneous or package freight, there is a tractor which draws after itself a number of trailer hoists. All movements, both of travel and of hoisting, are controlled by an operator who rides in the tractor cab. The machine or train of tractor and trailers rarely is stopped by the operator upon the main track, but only upon the cross-tracks for hoisting and lowering loads. As a few trains will handle a large amount of freight, there is in practice seldom more than one train upon the same cross track at one time.

The main track is thus kept free for travel, and the side or cross tracks are designed for loading and unloading. In Germany, where automatic lines are installed, there is a block system to prevent interference. As a concrete example: At the foot of Duane Street, New York, at the Erie Station, the dray backs up against the platform. The drayman is only obliged to place the freight upon this platform, but in order that it may be assorted according to the marks, the railway company employs a man to help the drayman.

Instead of thus piling the loads upon the floor of the platform, it should be piled as per consignments upon separate flatboards. It is therefore assorted by the drayman as unloaded and is ready for hoisting. Each flatboard with its load is then hoisted, and as it comes to the scales, which are a part of the overhead tracks, it is weighed and then is routed to its destination, the process of checking and rechecking being the same as when the hand-truck is used. Provision is therefore made for all the usual assorting, weighing, routing, distributing, checking and rechecking.

The lowering of the separate flatboards is, for the most part, done upon the cross tracks; or else the cross tracks perform the function of relieving the main track of too much traffic.

Mr. R. P. Bolton.—Mr. President and Gentlemen of the Municipal Engineers of the City of New York: I thank you for the opportunity of speaking a few words on a subject with which I have been somewhat closely associated in my past career, in some of those foreign countries, the circumstances of some of which have been shown upon the screen this evening. I have also had some part in designing and installing machinery of the general class described by the speaker of the evening. I am glad to have the opportunity

of seeing and realizing that there is enough energy left in Municipal Engineers to form this Society, notwithstanding the operations of the Bureau of Municipal Research; and also to feel that there is a body of engineers, which will, I hope, devote attention to this important subject, which up to the present time appears to have been left almost entirely in the hands of our Dock Commissioner.

As regards the sore need for improvement in methods of transportation and handling of freight, Mr. Harding hits the nail on the head, and exposes the difficulty of teaching railroad engineers that a freight car is an apparatus which is efficient only in one direction—that of a horizontal straight line, upon diverging from which it becomes a very inefficient appliance.

The presentation of the subject has covered practically the whole range of appliances applicable to the handling of freight, with the exception of two—one in which this country is pre-eminent—the elevator, and the other, the long-used apparatus known as the chute.

There are evident ways of utilizing the elevator and the chute. So far as our water front is concerned, you will have observed by the views presented that we stand about five hundred years behind the port engineer of Europe, who has got so far as to build a five-story building on the water front, whereas we, along the land on our west-side water front, which is the most expensive and valuable land in the City, have not got beyond the construction and use of a single floor.

Upon this we have been shown the congested conditions that exist because we are trying to do ten times the amount of business upon the same floor area that our forefathers possessed. We build an expensive pier running out into the river, upon which we endeavor to do all the work of handling trucks and goods, and obstruct the water with car floats tied up alongside. I fail to see why we do not first make better use of the land we have secured at such great cost.

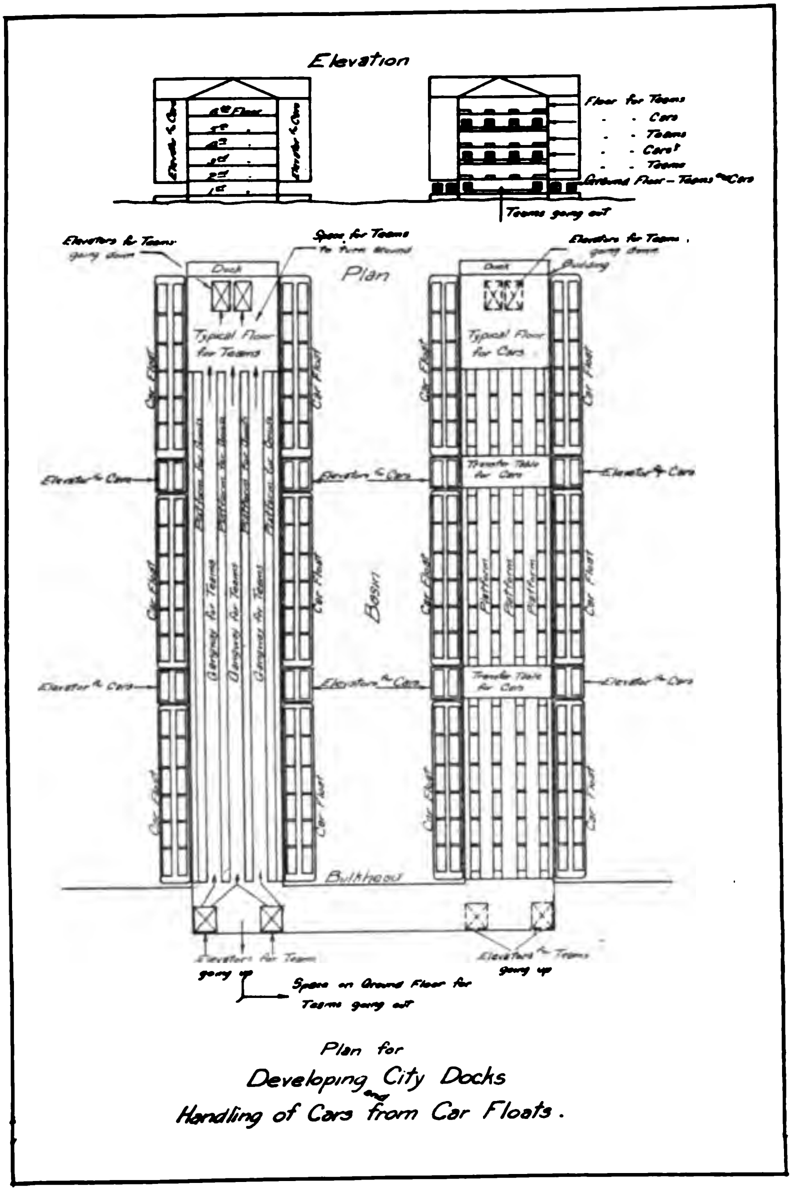
Why do not we apply to this difficult situation the principles that we apply to business buildings? The plan of connecting piers together with railroads may be a suitable method to follow where a port lays all along one side of a harbor, but I fail to see that it applies to the conditions of New York City, and particularly to the west side of the Borough of Manhattan, which is the housing point for the transatlantic lines and high-class passenger traffic, because that part of the borough is near to the hotels, business centers and railroads. Now, to join these docks together, for the purpose of moving railroad materials, with an overhead freight railroad occuping the finest west side thoroughfare, would be an entire mistake. What is needed on West Street is passenger transit. There is no place where less opportunity or need exists for

handling freight in an up- and down-town direction than upon West Street and the Marginal way, where everything can be much more readily handled by water and truck if proper methods be found for the purpose. Undoubtedly a difficult situation confronts the Dock Commissioner to-day. He is short of room for steamships, for the reason that the railroads have got possession of too many of our piers. Then make them use one or two in place of eight or ten, by developing them with proper appliances and an intensive use of the space, by additional floors. By the application of the principles of handling goods which Mr. Harding has so ably described to-night, we could increase the capacity of these piers and basins, and the saving in rentals alone would be a very large amount. I am in hearty sympathy with the plan that the City itself should develop the dock properties, but the interests and future of the Borough of Manhattan, and particularly of its west side water front, are far too precious to be fooled away in such miserable misuse as prevails to-day. Provisions must be made, with forethought of the needs of fifty or one hundred years to come, to utilize the available space to its utmost capabilities. There are, in a word, other opportunities and methods for a solution of the pressing problem of the moment, which do not involve the sacrifice of the whole character and appearance and future use of the west side of the Borough of Manhattan.

The intensive utilization of the extremely valuable area of dock property seems to be the most economical as well as practical course for the railroads, which are now paying rent upon a multiplication of leases, which could be reduced to a single leased property, if suitable methods were followed for its development for the desired purposes of transfer of goods between the car and the truck. Such a development is shown in the accompanying diagram, Plate 12, by which a five-story building upon a dock 700 ft. by 100 ft. would afford space for 150 cars, with ample space for teams on intermediate floors, all goods being disposed of by chutes from the team platforms to car platforms or vice versa. The cars to be lifted or lowered on exterior elevators descending to the level of the car floats, and provided with transfer tables to align the cars on the floors. Teams arriving on street to be elevated to the proper floors and to descend at the opposite end making their exit unobstructed.

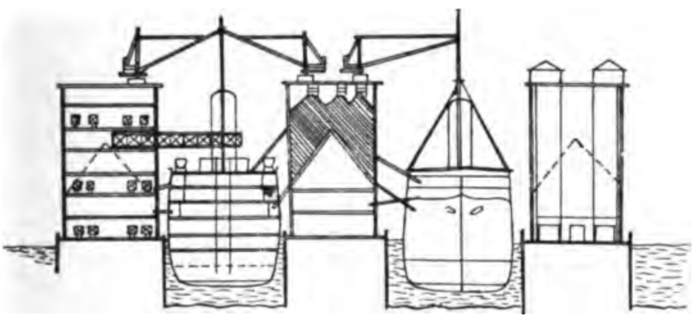
Such a development eliminates the disadvantageous features of crossing West Street either at grade or overhead, leaving that thoroughfare free for its legitimate future utilization as a rapid transit route for passenger traffic.

The early disposition of the difficulty of finding room for the ocean-going steamships would be greatly facilitated by the prompt adoption of plans of this nature, for such buildings could be constructed much quicker than could railroads. The future use of this



Plan for
Developing City Docks and
Handling of Cars from Car Floats.

PLATE 12.



Elevation of
Proposed Island Dock
for
Rapid Handling of Largest Ocean Liners

PLATE 13.

part of the port will no doubt be almost exclusively that of such vessels, and their convenience would be served by such railroad terminals arranged conveniently in their vicinity, and modifies only in a practical way the joint terminal plan of the Special Committee of the Board of Estimate and Apportionment.

It remains an open question whether the stereotyped arrangement of piers and basins now in existence is the best for this or other purposes. Our street system, laid out at certain local intervals, does not involve equal advantages for docking purposes, and other distances between piers will no doubt be required for future steamships exceeding 1 000 ft. in length.

For rapid handling of such vessels some better methods than the present will be required. Possibly a development of the Liverpool floating stage, desirably placed, and provided with every facility for handling passengers, baggage, express freight and fuel, on an intensive and rapid basis, would be preferable to the present scheme of docking such vessels at the end of a street. In this, as in the matter of the pier-head development, recognition should be accorded to modern methods of transportation of materials, and dependence upon wheeled motion modified in favor of elevators, conveyors and chutes.

The means for coaling large vessels compare very disadvantageously with processes followed on the Great Lakes. We should have overhead storage sufficient to coal the largest vessels' bunkers in an hour, and proportionately rapid means of removing and loading cargo.

Why should a large vessel, involving many millions of investment, be tied up to a pier for several days while these slow processes are carried on? The mere interest on investment or charter cost would pay liberally for such improved means and methods. For the largest vessels, narrower basins would appear to offer greater facilities, enabling the processes of discharging and loading to be carried on from both sides at once. Such an arrangement is shown in diagram herewith, Plate 13. This scheme would provide basins of say 120 ft. width, with piers on either side, on which buildings would be erected, provided with coal pockets at a suitable point, to reach the bunker openings by chutes. The rapid discharge of cargo could be effected by cranes traveling upon the roof of the buildings or by double-girder travelers, run out between the masts and locked together, upon which a telpher system could be operated.

With the suitable provision of elevators, freight cars and trucks could unload on upper floors, whence their freight could be delivered to the hatches by chutes. Inversely, goods discharged from the boat would be landed and sorted on upper floors and delivered down chutes to cars or trucks.

A careful and open minded study of such and other methods would undoubtedly result in the development of highly effective means of utilizing the space and time which are now so largely wasted.

PERCY C. BARNEY, M. M. E. N. Y.—Mr. President, I notice in the different kinds of apparatus described this evening that the old shear legs, which were really the first mechanical means for stepping masts and placing heavy weights on vessels, has not been mentioned.

The first type of shears probably consisted of two oars crossed and lashed together in the shape of the letter "A" and held in an upright position by guys with a block to lift heavy objects secured where they were lashed together. Spars were later substituted for oars and blocks were fastened to either spar as high as necessary or where they crossed.

Columns made of plates or structural shapes superseded the spars and then later the guys were replaced by a third column, first with a fixed base, then later with the lower end attached to a long screw. By turning the screw, the foot of the third leg, likewise the top of the shears, could be moved backward over the object to be hoisted, and then by reversing the movement of the screw the top of the shears would be moved forward so that the load could be landed at some distance, either at a higher or lower level.

In the last form of shears this third leg was secured to a shaft at the lower end and a joint made in the leg about one-fourth of its length from the base so that by raising or lowering the joint the top of the shears would be moved outward or inward. The top of the three legs was secured to a horizontal shaft from which straps were suspended carrying multiple blocks for heavy and slow moving weights and a single block for light and rapid moving weights.

The capacity of the shears at the Boston Navy Yard was 100 tons and they could raise an object 25 ft. back from the edge and place it on the deck of a vessel 40 ft. from the edge of the wharf.

The great handicap to the use of the shears was the large space required and to the fact that the ship had to be brought to them instead of the shears to the ship.

These objections resulted in doing away with the shears and developing in their stead the locomotive and gantry cranes, among the first examples of the former being the 40-ton locomotive crane at the New York Navy Yard.

MR. HOAG.—The half arch and gantry crane appear to have been the next step in development. Mr. Harding, is it not a fact that abroad, the cars served by these gantrys or half arches are invariably open at the top—that is, cars without a roof?

MR. HARDING.—Many of the cars are open, but they are now introducing the box cars, the same as in the United States.

At Tehuantepec, Mexico, the cars have large hatchways in the roofs.

As to the freight movements from the west side of Manhattan, a few figures may be of interest.

It now costs about 95 cents per ton to transfer the freight from the dray at the railway piers in New York to the time it is made up in through trains for the West.

By the use of the elevated railroad along West Street and a tunnel and mechanical transferring machinery, there would be a saving of 51 cents per ton.

Mr. Tomkins by his plan proposes to save that 51 cents for the people of New York. There have been 25 years of argument, of discussion to obtain a practical engineering plan. Some action must be taken at once to continue for New York its commercial supremacy. The Commissioner insists and all agree that action is now necessary, but the Commissioner said long since if anyone has a better plan let him submit it.

MR. HOAG.—Gentlemen: I think Mr. Bolton's remarks demand a few counter comments from me because of my familiarity with Commissioner Tomkins' schemes for improving the freight handling conditions along the North River.

Congestion exists in the form of river-slip, pier and street congestion, and the necessity for a remedy is the motive back of the plans for improvement suggested by Commissioner Tomkins. This is a situation that has developed within the last few years, and is rapidly becoming aggravated until now some action will have to be taken working towards a relief.

The more closely a natural order and condition of things is followed as against some artificial creation, which ignores the natural order, the more surely will the idea of economy be conserved. The more artificial any proposition is, the more expensive it is bound to become in the end. Terminal facilities materially affect the per ton charge for handling freight which the consumer pays. If these charges can be reduced, at the same time relieving the congestion along the waterfront, a double purpose will be accomplished. The position of the Dock Commissioner is that his plan for relieving the congestion will operate in the economical handling of freight as well. The natural location for a railroad is on dry land, and any attempt to force the occupancy of water space for such a purpose is working against the natural order of things and invites and entails unusual expenditure.

The great trouble with the North River waterfront of Manhattan to-day is that forty per cent. of it is used as a "marine car yard," which Commissioner Tomkins proposes to place on dry land, and devote the limited North River waterfront of lower Manhattan to marine commerce.

The rapid and more recent growth of this great City demonstrates the absolute necessity for providing the means for expansion in any great enterprise, and in this respect the adoption of the unit terminal as proposed in opposition to Commissioner Tomkins' scheme would ultimately fail in the accomplishment of its purpose because of the limited availability of initial piers on the lower North River waterfront for the inception of such a scheme, and as time goes on and more piers are needed for expansion of business as would inevitably be the case, this relief could not be obtained. The plan proposed by Commissioner Tomkins is perfectly elastic in this respect, as every opportunity for expansion will be available along the easterly side of West Street and of Twelfth Avenue, from Battery Place to West Sixtieth Street.

Pending the construction of freight tunnels, extending from a classification yard on the Jersey meadows under the North River to and connecting with the proposed four-track elevated railroad along West Street, a temporary installation of transfer slips for car floats is proposed on the North River in the vicinity of West Thirtieth Street, comprising about 30 slips. The railroads, by means of car floats, would concentrate their activities *from* the New Jersey railroad terminals in the morning, transferring freight to the freight elevated railroad, by means of which it would be distributed to the various railroad warehouses along the easterly side of West Street.

This movement of freight would be reversed in the afternoon. The merchandise would be taken from the warehouses over the four-track elevated freight railroad to the transfer bridges, and thence by car floats back *to* the New Jersey railroad terminals, where unbroken rail connection can be made to any part of the country, even to the Pacific Coast. The completion of freight railroad tunnels under the North River will create an unbroken railroad connection between warehouses and the destination of any freight. This seems to me the most logical solution of this entire problem, and it saves for the North River waterfront its legitimate function in the form of most excellent facilities for marine commerce, forcing the railroads to operate where they ought to—on dry land.

I will add that the New York Central Railroad Company has a freight station on St. Johns Park, below Canal Street, and this company has such faith in the wisdom of this system and method

of handling freight, that if the City does not build a freight elevated railroad, the New York Central Railroad Company proposes to do so.

With such an installation the opportunities are numerous for the adoption and operation of any of these devices which have been described by Mr. Harding, combining in the warehouses, elevators, chutes, motor trucks and telferage systems, thus minimizing the cost of handling, and ultimately the terminal charges per ton.

THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.

Paper No. 71
PRESENTED MARCH 27, 1912.

DRAFTING METHODS OF THE BOARD OF WATER SUPPLY.

BY CLARENCE F. BELL,* M. M. E. N. Y.

WITH DISCUSSION BY

ALFRED D. FLINN, S. W. HOAG, JR., GARDNER L. VAN DUSEN, CLARENCE F. BELL, HERMAN A. RUGE, VERNON S. MOON, EDWARD L. HARTMAN, ARTHUR H. PRATT, LEON G. GHETTI AND FRANK E. WINSOR.

The first step in the engineering organization of the Board of Water Supply was the formation of the Headquarters Drafting Division. Later the Real Estate, Architectural, Designing, Mechanical and Executive Divisions were added at Headquarters while the field departments were being organized.

PRELIMINARY WORK.

Before the work on the Catskill scheme could really be begun along any definite lines, permission as to the route to be adopted and the method of carrying out of the work had to be obtained and a series of diagrams, principally to show the need of an additional supply for New York City, and a large map showing the proposed watersheds, reservoirs and the line of the aqueduct into the City were prepared and exhibited before the Board of Estimate and Apportionment on October 9, 1905, and later at public hearings before the State Water Supply Commission in the City of Kingston. On this map the water courses, railroads, cities, towns, and the

* Assistant Engineer, Board of Water Supply.

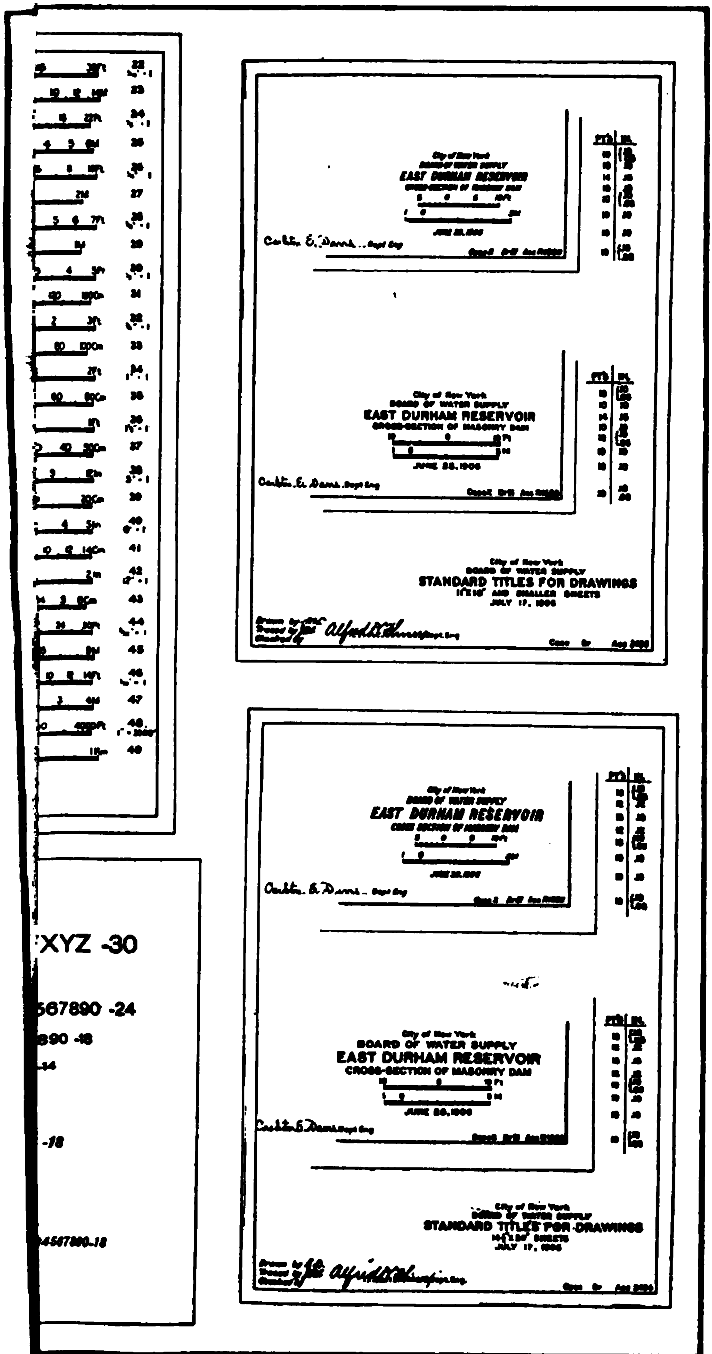
state, county and township lines were traced from the U. S. Geological Survey maps, and the watersheds and aqueduct lines of the Croton and proposed Catskill systems were then plotted. The aqueduct was shown starting from the east end of the Ashokan Reservoir, crossing the Hudson at New Hamburg. The Rondout Aqueduct and the future extension were also plotted and the profiles were shown below. Later a similar map and profile was made and from it permission was granted to change the main aqueduct route by starting at the Olive Bridge Dam, running through Ulster and Orange counties, crossing the Hudson at Storm King and connecting with the original line back of Cold Spring, this line, although somewhat longer, being easier and cheaper to construct as there is more cut-and-cover work.

As it was necessary to get this work out in a hurry (about a month), every man was employed on whatever seemed to be the most necessary, but as soon as these rush jobs were completed the work began to be systematized and, working along this line, a series of standards for use on all work was gotten out.

Standard Sizes.

Six standard sizes of sheets were decided on, three of them to have a height of 11 in., the same as our correspondence paper, so that they could be used conveniently in reports, and having the three widths of 8½, 13 and 18 in. or longer, the borders of drawings made on sheets having these sizes to be ¼ in. from the top, bottom and right edges, while on the left a ¾-in. margin was left for binding purposes. The other three sizes were 14½ by 20, 20 by 29 and 26 by 40 in., or longer, with the border ½ in. from all edges. These sizes are for prints or finished paper drawings, while tracings are cut ¼ in. larger on all sides for purposes of protection. It was decided to use the 20 by 29-in. size for contract and working drawings, but for contract drawings, while sheets longer than 29 in. can be used, the 20-in. height is strictly adhered to. The contract pamphlets are 10¾ in. in height so that when a 20-in. sheet measuring 19 in. between upper and lower borders is lithographed to one-half the original scale, it can be bound with a ½-in. margin outside the border and have no horizontal folds. The lithographing to one-half the original scale allows the use of the foot rule.

PLATE 14.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
BELL ON DRAFTING METHODS
OF BOARD OF WATER SUPPLY.



y Drawings.

STANDARD TITLES AND LETTERING.

It was decided to have standard sizes of titles and lettering for these different sized sheets, so a series of titles was made up, a small title for the letter size sheets, a larger one for the 14½ by 20, and a still larger one for the 20 by 29-in. or larger sizes. It was decided that the size of lettering for notes should generally be the same for all drawings and that all titles and the sub-titles under the different parts should be made vertical except for sketches and diagrams on which inclined lettering could be used, as less of the draftsman's time and care would then be necessary. The letters were made to conform to presswork standards and the heights were given in hundredths of an inch and in "points" as used in presswork.

PRINTING PRESS FOR TITLES AND NOTES.

As the standards were strictly adhered to and the quality of work required was high, it was found that a great deal of time was spent by the draftsmen on titles, so it was decided to use a printing press to save time and reduce the cost of drawings.

At first the titles were struck off on paper from an ordinary press and then traced, but early in 1907 a special "title press" was obtained and since the middle of that year practically all the titles and sub-titles, and generally the long notes have been printed on all finished drawings (tracing or paper) made in the New York office and at times on those made in other departments. The great advantage, aside from the saving in time and expense, is in the uniformity of appearance.

In printing the titles by the press, the drawing is laid on a rigid, horizontal pad, around which a table has been built large enough to allow drawings to be laid out flat without danger of creasing, and the chase in which the type has been set is brought down on this. For a long time a sprinkling of either pounce or magnesia was applied immediately after the printing to hasten the setting of the ink, but both of these got on the men's clothing and gave the work a grayish appearance, while the titles never became either elbow or benzine proof, and it often happened that after much handling, the titles would have to be retouched and sometimes altogether renewed by hand. At one time we tried putting a thin coating of collodion over the titles instead of using pounce, but the

resulting gloss prevented good photographic work, while the collodion soon lost some of its transparency and looked dirty.

A few months ago we tried using "Fixitif," a liquid used by artists for setting charcoal sketches, and we are still using it with most satisfactory results. A templet, made by cutting out the paper proof submitted by the printer, is placed over the title and a light coating of fixitif is sprayed over the printing from an atomizer, no pounce being used. This coating is almost invisible, preserves the black appearance of the ink, which is of great advantage in photographing, and in a few hours (over night) the printed work is finger-proof and practically benzine-proof. The first sample job treated in this way has been hung up, exposed to the dust and air for several months and wiped several times with a benzine cloth with no noticeable change in appearance resulting.

Furniture.

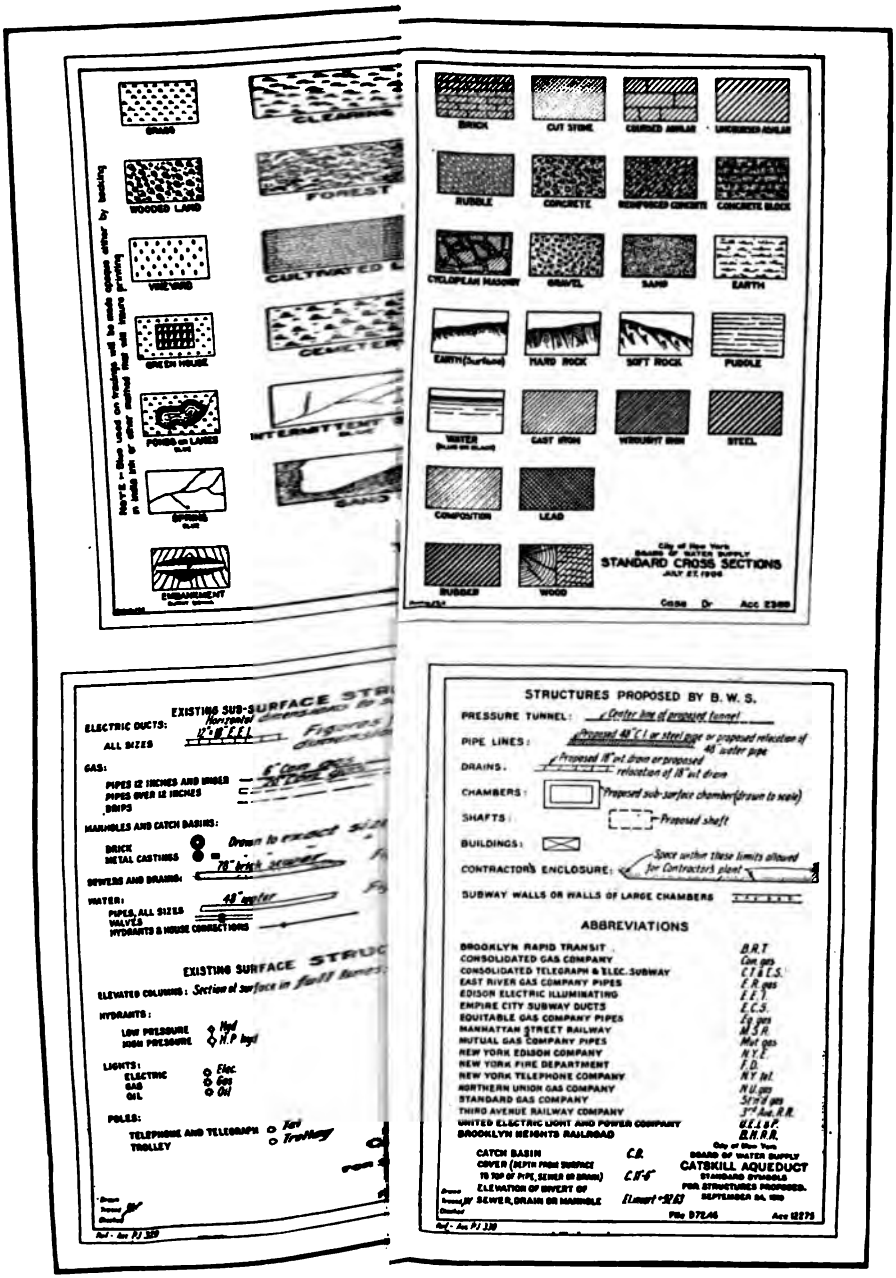
While the standards were being prepared, office furniture, such as drafting tables and filing cases were designed. The first of these have been added to from time to time and practically all large special filing cases used by the Board were designed in the Drafting Division.

Designing and Drafting.

Since the organization of the Designing Division, that division and the Drafting Division have worked together, and speaking generally, computations and preliminary studies are now made by the former, while finished drawings are made by the latter. The Architectural, Real Estate and Mechanical Divisions to a certain extent work independently, but the men of all divisions are frequently interchanged as the work may demand; in this way the necessity for extra men for rush work is obviated. Plate 16 is the organization diagram for the Headquarters Department and shows the distribution of the force. A similar diagram was made for each of the other four departments as well as one for the entire engineering force.

The steps of the system under which the Designing and Drafting Divisions work together are: Preliminary studies on detail paper are made, approved by the Designing and Department engineers and sent to the Assistant Engineer in Charge of Drafting

PLATE 15.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
BELL ON DRAFTING METHODS
OF BOARD OF WATER SUPPLY.



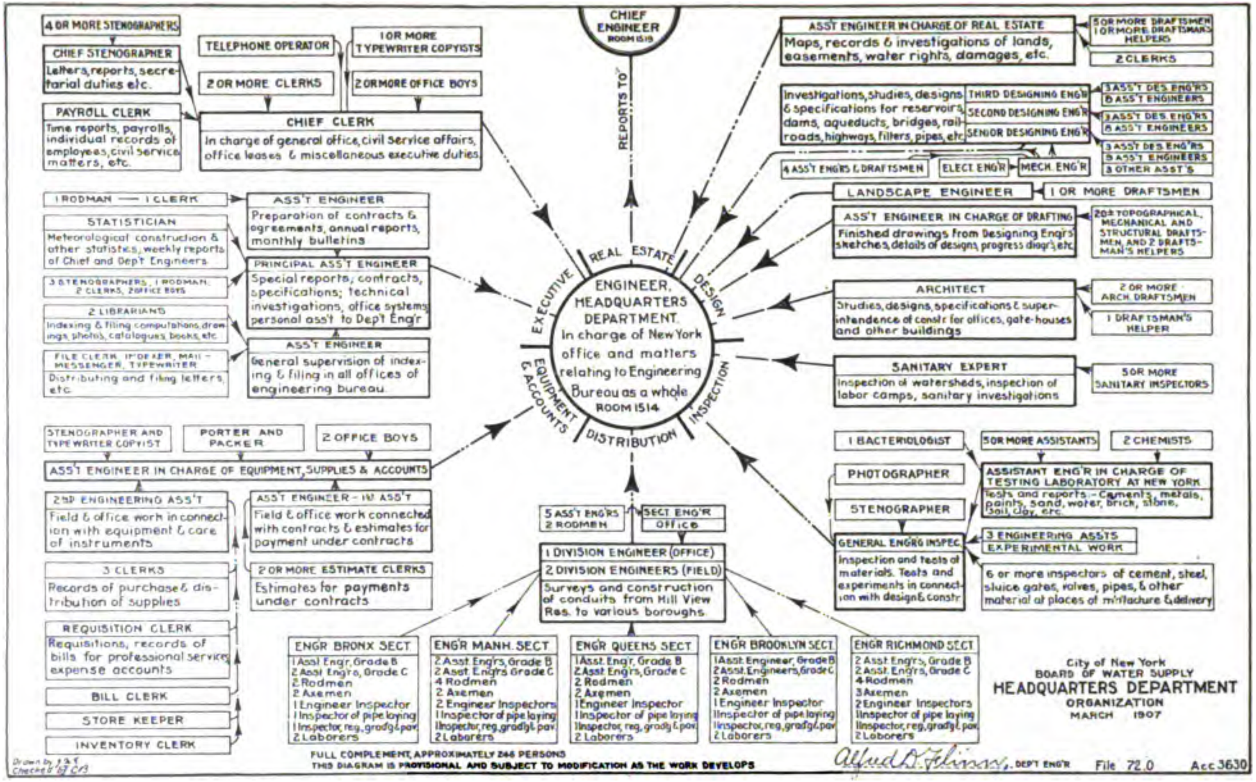


PLATE 16.—TYPICAL ORGANIZATION DIAGRAM.

with an instruction sheet. A drafting "progress form" is then made out, on which the contract number, sheet number, final accession number, the accession numbers of the original studies, a brief title and the date on which the work is received are filled out. This form is then inserted in the "progress book," and the studies, instruction sheet and a ticket marked "ready to trace" are all pinned together and placed in a case until a draftsman is available. When the work is assigned to the draftsman, his name and the date are written on the progress form, an entry is made on the monthly record which shows work begun and completed, and the job is turned over to him with any additional instructions that may be necessary. Green is a danger sign with us, so anything either underlined or ringed with green is omitted on the final tracing, although it may go on later and is used in plotting and for checking. When everything has been traced, the draftsman initials and dates the "ready to trace" ticket and turns the work in. A corresponding entry is made on the progress form and another entry and a "drafting check" ticket are made for the checking, all steps being entered and ticketed this way. *This* check is for drafting errors only, not those of design, and errors are indicated in blue pencil on the tracing.

On the upper half of Plate 17 are shown the so-called progress form, the corresponding work tickets and the monthly record sheet. The sketch in the lower left corner is of the plan case in which drawings are kept when not in use, the shelves being labelled to correspond to the work tickets.

When this drafting check has been accepted and the corrections made by the man who did the tracing, a blue print is sent to the man in charge of the design, who has the print checked in red, and the corrections and additions indicated in yellow. The draftsman makes corrections from this print, a check is given and the printer then prints the title and sub-titles, after which the tracing is sent for final check and signatures.

A complete new check is then given and after any final changes have been made, the drawing is signed. If it is to be used for study purposes no signatures are necessary, except on drawings for issue outside of the Board's offices. On working drawings, the Designing, Department and Chief engineers sign, while on con-

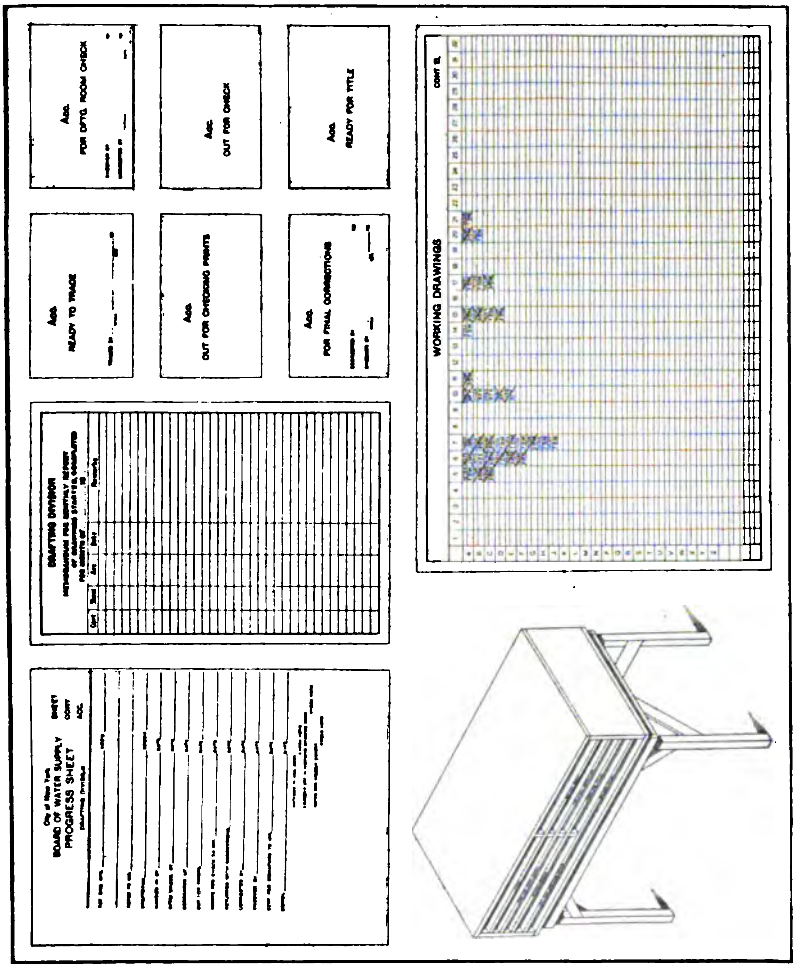


PLATE 17.—PLAN CASE, PROGRESS FORMS AND WORKING DRAWING RECORD.

tract drawings only the Designing and Department engineers sign, as the Chief Engineer signs a title page for all the drawings, except for small contracts needing only four or five sheets, in which case a title page is not used, and the Chief signs every drawing. One or more of the consulting engineers also sign the title page or all sheets for a contract the same as the Chief Engineer. The customary proceedings regarding the signature of contract drawings was investigated by inquiry among the government and state departments, the Pennsylvania R. R. and others; the present system was developed from these.

Accession Sheets.

I have used the term "accession number" several times and perhaps I had better explain it. Every drawing made by or acquired by the Board is given an accession number by which it can be referred to in notes on other drawings, in computations, or correspondence, and the record of each is entered on an accession sheet, these accession sheets being 11 by 18 in. in size and arranged to hold entries for fifteen drawings. An accession number is given to a drawing as soon as it is started or as soon as there is any need of referring to it in any way. If a brown-paper drawing is to be kept in the files, it is accessioned and as tracings are made from it, is indorsed: "Traced partly on Acc. ———".

The headings on these accession sheets are: "Title", under which the title is written in complete; "Description", a brief description being entered; "Date"; "Purpose", the purposes being grouped under certain headings; "Kind of paper and size", abbreviations being used in this column; "File", this column being for numbers under which the drawings are filed; the last column is headed "Remarks".

Contract Drawings.

I have tried to give an idea of the general system under which the work is carried on and will now go more into details. Of course, any system must be more or less elastic and drawings are at times made from start to finish in the same division.

The first sheet in a set of contract drawings is the locality map. On this are shown the aqueduct line, roads, railroads, towns and any information that might help interested parties in locating the

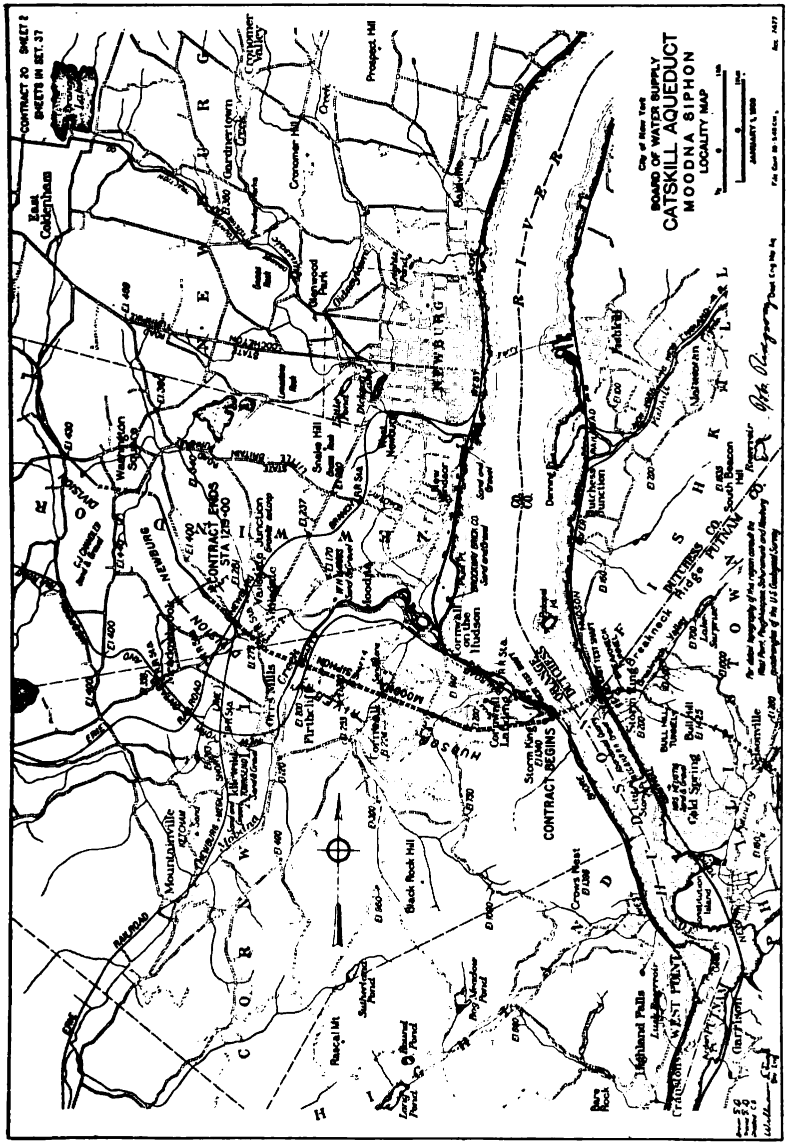


PLATE 18.—CONTRACT DRAWING.—LOCALITY MAP.

work and in determining the easiest routes for transportation. The topography is pantographed to a scale of ½ in. to the mile from the maps published by the U. S. Geological Survey and the aqueduct line and other points are then plotted, that part of the line between the contract limits being made much heavier than the rest of the map. Plate 18.

The next sheets are generally those showing the plan and profile in detail. Location surveys, contour maps and profiles were made along the entire line by the field departments and from these, the contract plan and profile sheets are made. The plan takes in a few hundred feet on either side of the aqueduct, shows stationing and other center-line information, shaft and portal locations, all structures, taking lines, borings, soundings and test pits. The profile shows the surface of the ground, the known and probable rock surface, geology, borings, soundings, test pits, the roof and invert of the aqueduct, and aqueduct structures. There is a legend explaining the symbols used on both plan and profile and a note regarding the reliability of the borings. The plan and profile sheet shown on Plate 19 is for a deep-pressure tunnel. Because of insufficient space the vertical scale is not exaggerated and the aqueduct cannot be shown very prominently in the profile. On cut-and-cover work the vertical scale is exaggerated and structures can be shown.

When special landscape treatment is called for, and at times for other reasons, the next sheets are those showing present and proposed topography on a much larger scale. On these, the topography as it will be at the completion of the contract is shown by full lines, while broken lines are used to show topography which is to be changed. On Plate 20 the area which is to be changed is outlined by a heavy broken line, the area to be grassed is shown by the fringe of grass symbols and the edging of trees indicates wooded area.

The rest of the sheets in a set of contract drawings have to do with the construction details. The several types of aqueduct, grade tunnel, pressure tunnel, steel pipe siphon and the construction and permanent shafts, depending on the types of construction, appear first; next, the drawings for chambers, culverts and other structures are shown, followed by any surface details, such as fences or retaining walls.

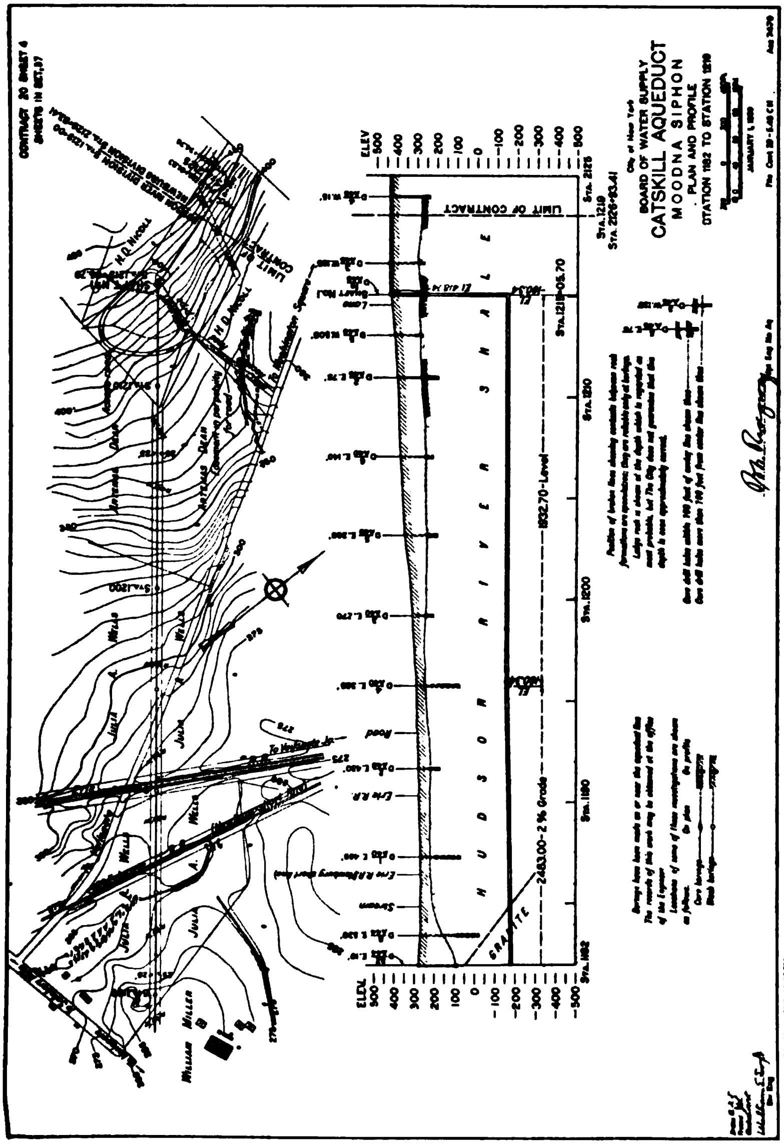


PLATE 19.—CONTRACT DRAWING.—PLAN AND PROFILE SHEET.

This description has been for an aqueduct contract, but in general applies about as well for other styles of construction, as for instance, a dam contract, in which the first sheet is the locality map, which is followed by others showing detail topography, borings, sections of the dams, and then necessary detail sheets.

Typical contract drawings are shown on Plates 21 to 24, inclusive.

Lithographing Contract Drawings.

During the preparation of a set of contract drawings, as soon as the number of sheets and the sizes are definitely known, a number of copies of specifications for the lithographing are prepared and forwarded through the Chief Engineer to the commissioners. These specifications whether for contract drawings or for other classes of work, are of standard form, giving sizes both of the original sheets and of the lithographic copies, time allowed the lithographer for the furnishing of proofs, information regarding coloring and time allowed for the completion of work.

The drawings are sent to the successful bidder, either as a complete set or in multiples of four, as the sizes are such that usually four sheets can be printed from one stone. Lithograph proofs in duplicate, usually four on a sheet, are sent to the Drafting Division, where lithographic errors are indicated in red ink, after which the division or field department in charge of the design gives them a final looking over and indicates any desired changes in green. The lithographer makes the corrections, being allowed to charge for the green but not for the red ones, and furnishes second proofs in duplicate, after which, if they are accepted, he prints the required number of copies for incorporation into the bound contract pamphlets, 400, 800, 1 200 or other number depending upon the importance and duration of the contract, and delivers as many as the specifications call for to the binder, and additional ones to the Drafting Division, a number of loose copies being always reserved for general use.

Working Drawings.

In getting out a contract, there is usually no time to go into all the details, so from time to time during the course of construction, the contract drawings are supplemented by a series of working drawings, each of these having in the upper right-hand corner, a

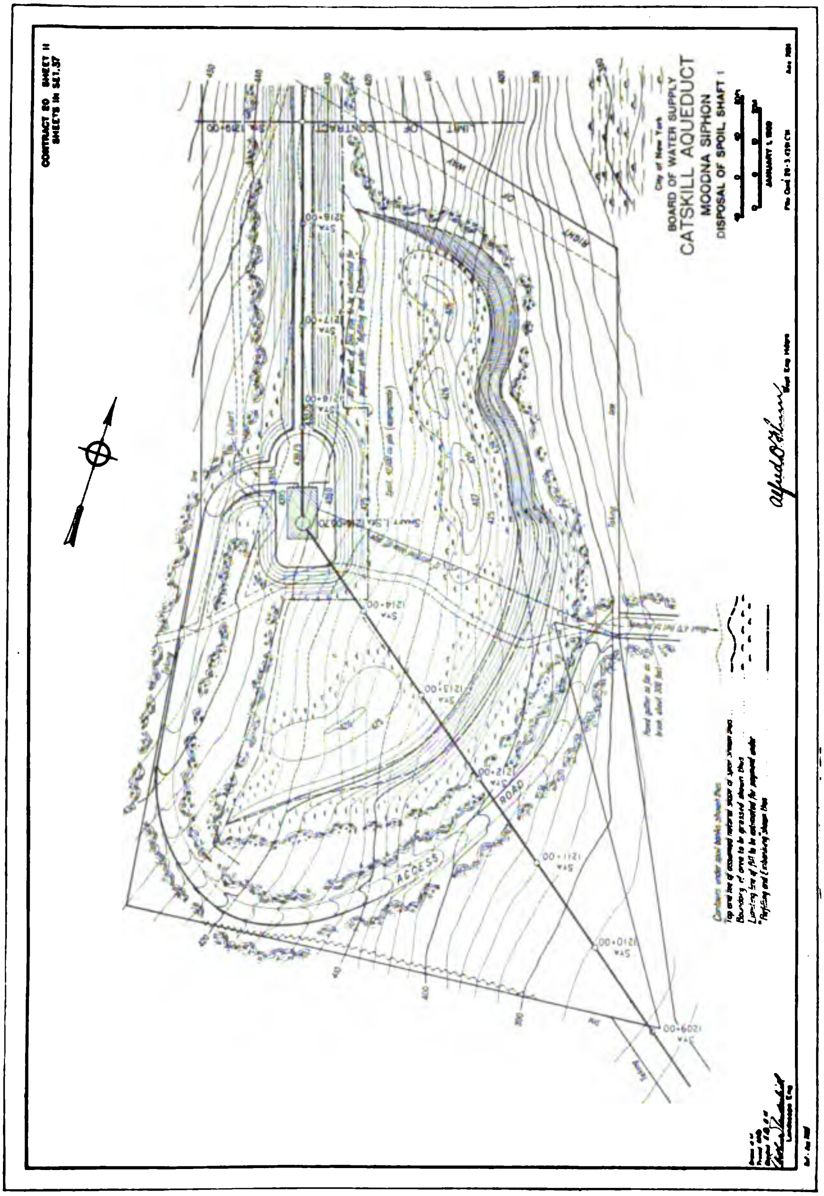


PLATE 20.—CONTRACT DRAWING.—SPOIL DISPOSAL SHEET.

number corresponding to the contract drawing to which it refers, followed by a letter of the alphabet, according to the order in which it is issued.

The general style of a working drawing can be understood by looking at any of the contract drawings shown on Plates 21 to 24, inclusive. A working drawing may be a modification of an entire contract drawing, or it may be a detail of any part of it. In the upper right-hand corner, the legend "Sheets in Set" of the contract drawing is changed to "Working Drawing," and the sheet is signed by the Designing Department and Chief Engineers. No shading is used except at times for sake of clearness, and rendering is used only in patches, considerable time being saved.

To avoid any confusion, as several men may be working on the same series of drawings, a sheet number and final accession number are assigned in advance to each drawing and entered on a "Working Drawing Record" form, together with the initials of the man to whom these numbers are given, a separate form being used for each contract. This form is divided vertically into columns numbered to correspond to the contract drawing numbers, while the horizontal divisions are lettered A, B, C, etc., and each horizontal division is again divided by a light line so that in each of the rectangles for a drawing there are two divisions, the upper for the accession number and the lower for the initials of the man to whom the number has been given. When the final tracing is started, a single red diagonal line is drawn across the corresponding rectangle and when the sheet is signed and issued, the other diagonal line is drawn. This form does away with any chance of having two drawings issued with the same sheet number, affords a means of ready reference and, if the need arises, the numbers for a full set of working drawings for any contract can be obtained at once. One of these forms is shown on the lower right-hand corner of Plate 17.

In the Mechanical Division an attempt has been made to have contract drawings, as far as practicable, serve as working drawings, to avoid expense and a multiplicity of drawings. In practically no case have full detail drawings of any piece of apparatus been made, but the work has been illustrated by assembled details, the entire assembled piece of apparatus being drawn to scale with sufficient

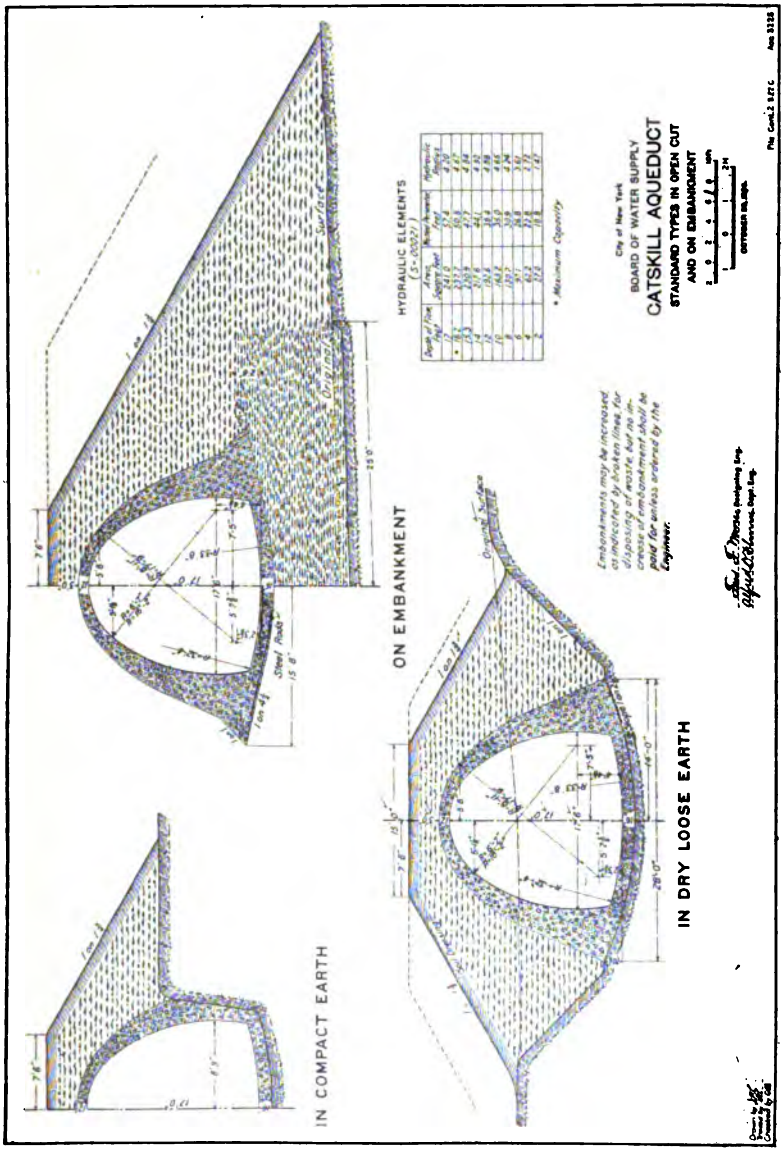


PLATE 21.—CONTRACT DRAWING.—CUT AND COVER AQUEDUCT IN EARTH.

number of elevations and sections to show all the parts fully dimensioned, and should the contractor wish, he can have his draftsmen simply separate the various parts from the assembly, and make up full detail drawings for himself. Where it is impossible to make the details clear upon such assembled drawings, local assembled sections to somewhat larger scale have been made. In this way it is possible to get on two sheets work which if fully detailed would occupy four or five sheets.

Working drawings, when made, have followed the same general principle, but it has been customary on such drawings to give each separate piece an index number, and to put upon the sheet a bill of material which contains the index number of the piece, the name of the piece, material from which it is made, the number required for each piece of apparatus and any such notes as might be necessary. These bills of material are, as far as practicable, so arranged that the parts made of a similar material and those which are assembled together in the apparatus shall be grouped together. They are of great advantage to the manufacturers' stock clerks in purchasing raw material and in making out shop orders.

Prints and Records of Working Drawings.

Blue prints of all working drawings are sent to all parties interested, and a black-line print on thin white paper is sent to the field department which has charge of the construction work, so that blue prints can be made there at any time. The tracing is then sent to the Board's photographer who makes a glass plate negative two-fifths the size of the original and from this, as many blue-line prints as are called for, the negative then being filed for future use. These photographs are of a very convenient size for handling and filing, and some are kept at the New York office while others go to the field offices for distribution, a record being kept on a simple form of all to whom full size and photographic prints are sent. These prints are issued according to regular schedule and extra copies are sent only on request.

As the work progresses, it is sometimes necessary to revise a working drawing and this revision may mean only a change of one or two dimensions, or it may necessitate a radical change, but in either case, all copies must be altered. A new negative is always

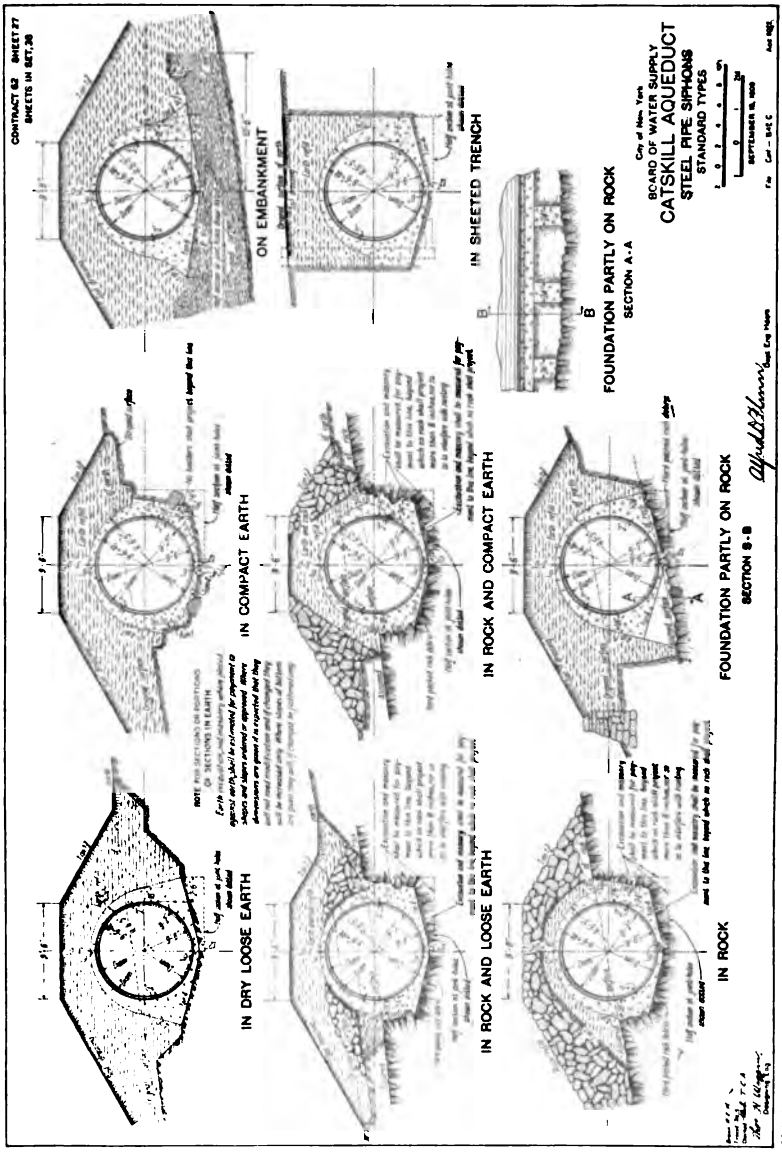


PLATE 22.—CONTRACT DRAWING.—TYPES OF STEEL PIPE SIPHON.

made, the old one being sent to us and destroyed, and if the changes are minor ones, instructions are sent to each person to whom a print has ever been issued to make these changes on his copy. If, however, the changes *are* important, new prints are issued and the old ones are returned and destroyed, the record of this being entered on the form. It is very important that these records be kept carefully as it would never do for old copies of a revised drawing to continue in use after the revision. The date of the revision is placed on the tracing and, as far as possible, when alterations are made, the revised portions are not erased, but are crossed or lined out.

When the type of construction is the same on several contracts, the same contract or working drawing may at times be used and in this case the contract and sheet numbers are not placed on the original drawing, but are filled in by the lithographer for contract drawings and by a clerk or draftsman on the prints of working drawings.

Black or Litho Prints.

Very often we have drawings which, while they cannot be used entirely as originally made, may still be in part the same as a new drawing which is to be made. An example of this would be two sheets, each showing, perhaps, sections of three types of cut-and-cover aqueduct, two of these sections being the same on each sheet while the other is designed for some special conditions not alike in the two contracts for which the sheets are to be used. In another case, the only differences may be in the notes. To make a complete new tracing takes time and is expensive, so we use what is called a "blocked out tracing print."

In the early days of our work, we used blue and vandyke prints altogether, and while, of course, blue prints are still being used we have practically discontinued the use of vandykes. To make these vandykes, as most of you know, it is necessary to first make a negative print (which has to be paid for) from which the positives are printed, and as both negatives and positives must be washed, there is a distortion which we sometimes found to be more than ½ in. in 30 in., and, as the distortion is not the same in both directions, scaling distances and tracing do not give very good results if accurate work is desired. Later on, however, we tried out a direct

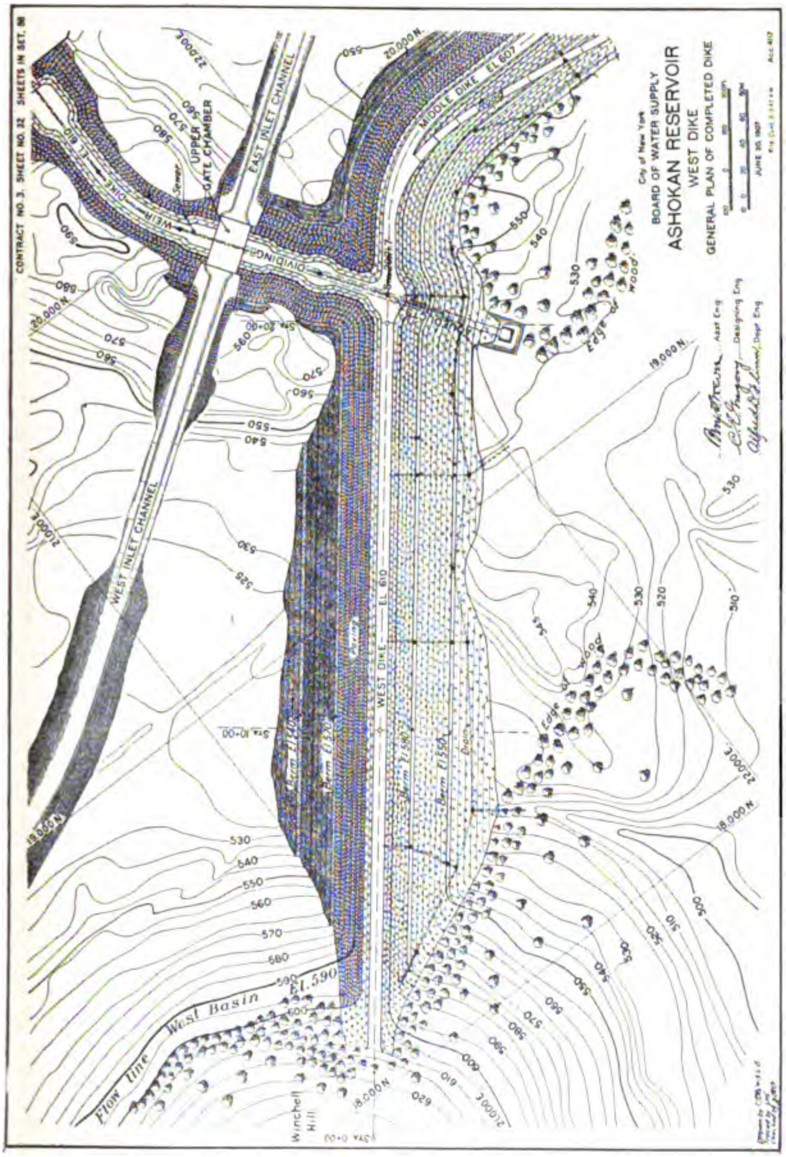


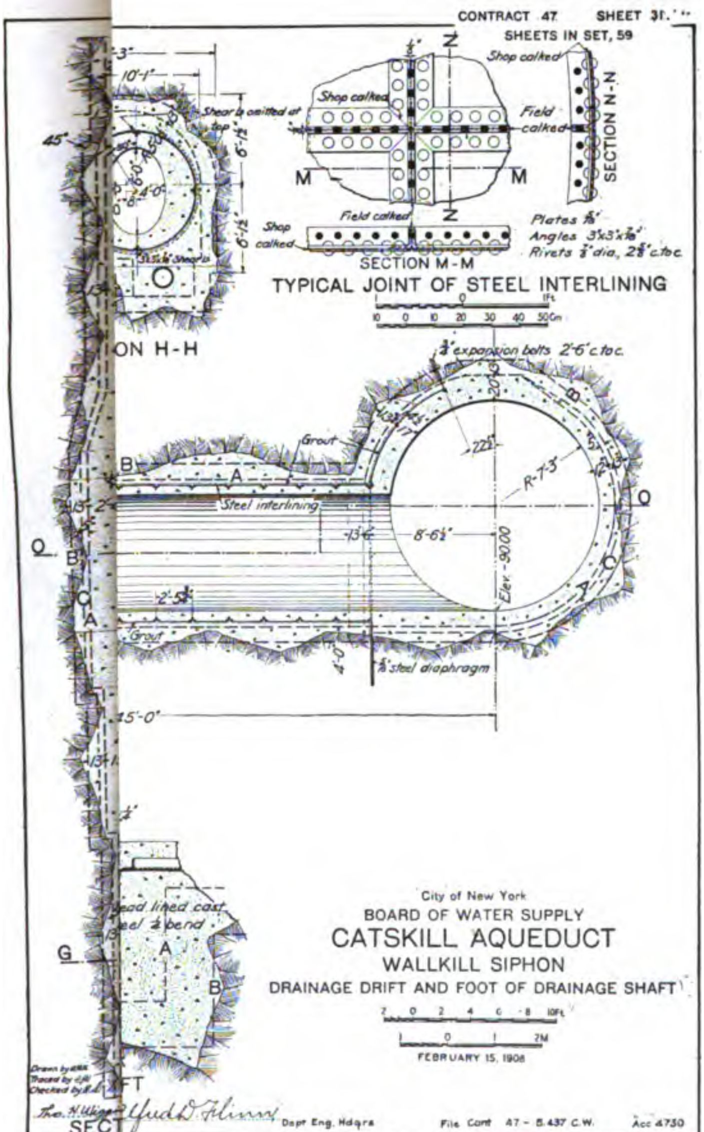
PLATE 23.—CONTRACT DRAWING.—PLAN OF DIKE.

black print or, as it is sometimes called, a lithoprint process with most pleasing results and a short description of this process may be of interest to some of you.

A blue print is made, using a very slow paper, the chemical coating on which is slightly different from that in general use. This print is not washed, but is placed face downward on a sensitized gelatine plate and an ordinary gum roller is run over it. The paper is then removed, having in this short time etched a negative on the gelatine. If any dirty spots appear on the plate, they are removed by a wet sponge. This plate is then inked with a special printer's ink from a gum roller, only the etched portions taking the ink, and a print, the exact size of the original, is obtained by placing the paper or cloth over the plate and running a roller over it. To make duplicate prints no further work is necessary except to re-ink for each impression. There is no distortion, and while a vandyke shows brown lines on a somewhat discolored background, the black print can be made on any material, and gives good black lines on a clean background which allows the making of additions in ink without changing the general appearance of the print. In the vandyke process the lines of the print are in the paper itself, while the lines of black prints are printed on the surface of the paper and can be removed with an eraser. A field office may at different times need blue prints of a drawing that is in the New York office, and for that purpose a black-line print on a thin, strong paper, which is an exact duplicate of the tracing and from which blue prints can be obtained, can be sent to and kept on file at the field office.

Now to get back to saving draftsman's time, when part of a tracing can be used direct for a new drawing. The parts not wanted are cut out of the preliminary blue print or else sponged out of the gelatine plate, the remaining parts are printed on tracing cloth and any additional work is drawn on by the draftsman. At first, to make these tracing-cloth prints elbow and benzine-proof, it was necessary to coat them with a shellac, but lately, by the addition of some chemical to the ink, this is not necessary and ordinary applications of benzine do no harm in 48 hours, or generally less, and it may be of interest to know that a print can be supplied and worked on the day following the order.

PLATE 24.
THE MUNICIPAL ENGINEERS OF THE CITY OF NEW YORK.
BELL ON DRAFTING METHODS OF BOARD OF WATER SUPPLY.



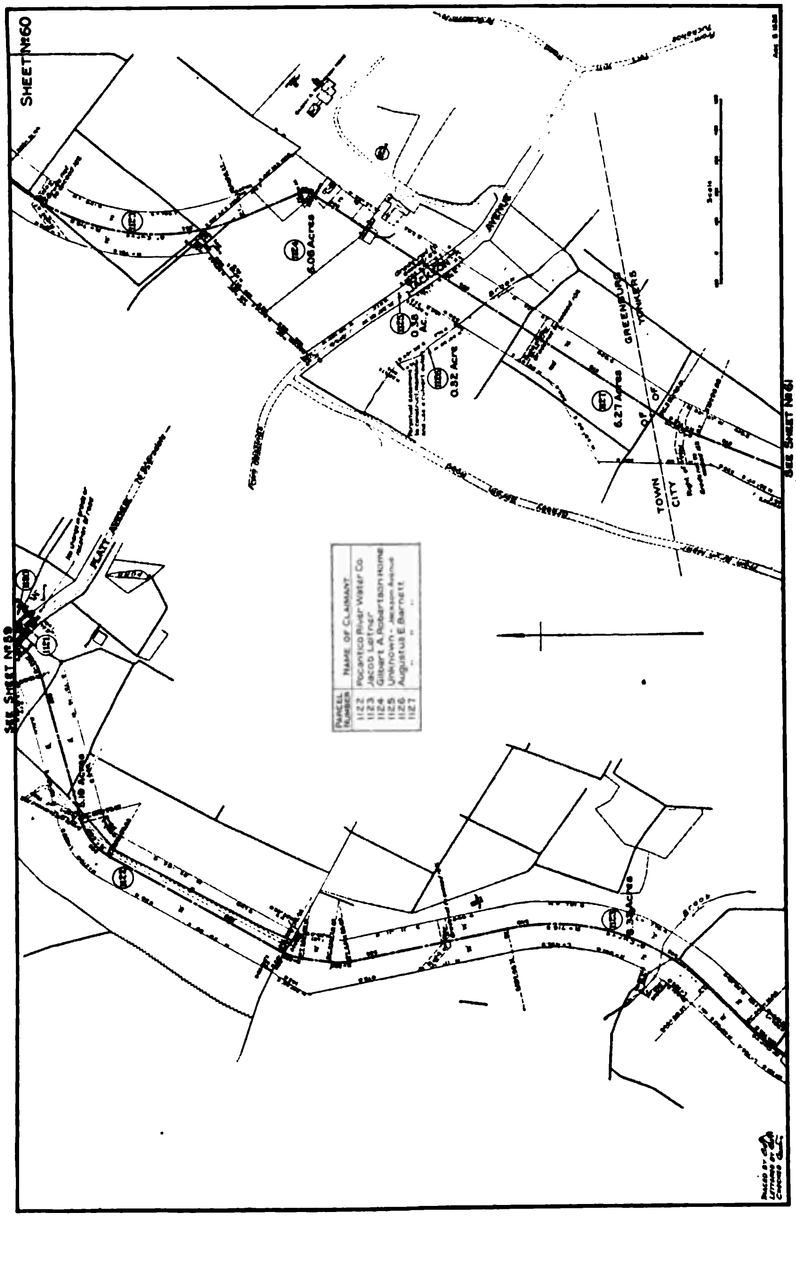


PLATE 25.—LAND-TAKING MAP.

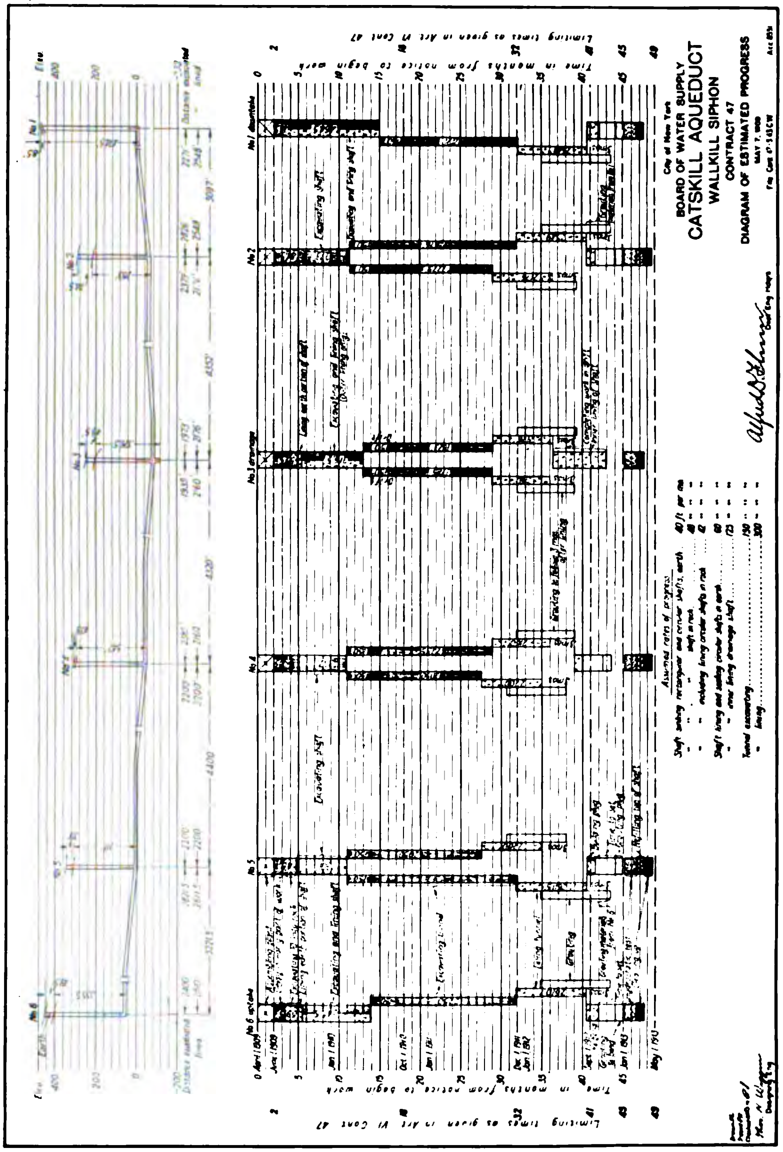


PLATE 27.—DIAGRAM OF ESTIMATED CONTRACT CONSTRUCTION PROGRESS.

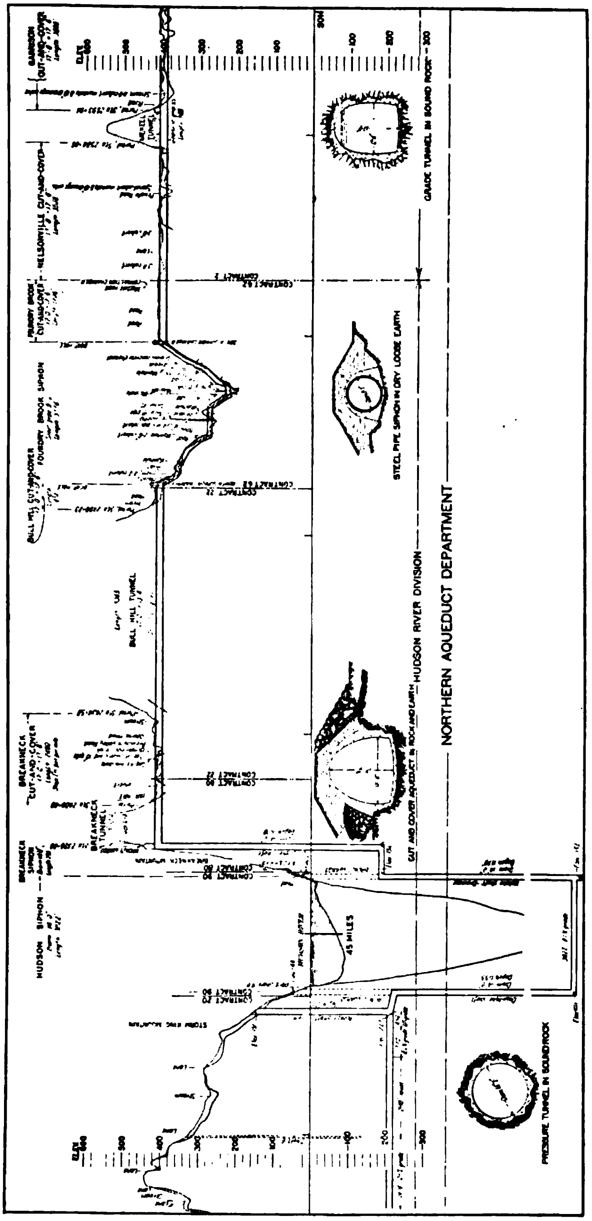


PLATE 28.—PART OF CONTINUOUS PROFILE OF CATSKILL AQUEDUCT.

limits with the name of the contractor, real estate section limits, and the names of parts of the work such as Olive Bridge Dam, Esopus cut-and-cover, Peak Tunnel, Rondout Siphon Tunnel, etc., being shown. A series of symbols was decided on and used on all sheets, these symbols being: Cut-and-cover aqueduct, full line; grade tunnel, broken line; siphon, series of crosses; shafts, solid circles; contractors' camps, solid stars; division offices, solid squares; and section offices, solid triangles.

This work was plotted very carefully on seasoned tracing cloth, checked as carefully by the field offices and then lithographed on the quadrangles, exact registering being required. These sheets have been used to great advantage in pocket folder form and as wall maps.

Continuous Profile of the Aqueduct.

Plate 28 may be of quite some interest as it shows a part of a continuous profile of the aqueduct from the Ashokan reservoir to Brooklyn. It is 62 ft. long, the vertical scale is 80 ft. to the inch and the horizontal scale is 800 ft. to the inch. On it are shown the surface, rock and aqueduct profiles; geology where it has been studied; names of different parts of the aqueduct; department, division and contract limits; road and stream crossings; information as to grades and elevations; types and dimensions of aqueduct, shafts, etc.; locations of aqueduct structures such as shaft chambers, tunnel portals, culverts and blow-offs; and at different intervals are shown some details of typical construction.

The profile was carefully drawn from contract drawings and prints were sent to the field offices. Criticisms and additions were indicated on these prints, and the tracing was changed accordingly, this being repeated until the work is satisfactory to all. As the construction work is not yet completed, additions are made on the tracing from time to time and on the prints which are in map cases at the different offices.

DISCUSSION.

ALFRED D. FLINN, M. M. E. N. Y.—Mr. President: The author of the paper has presented the subject clearly and interestingly.

There were two or three fundamental principles we had in mind in getting out drawings. First, the information was intended to be shown as clearly as possible, and in doing that the draftsmen have used different sizes of letters and weights of lines. Another consideration was to get drawings that would be presentable anywhere, and in all of this we have tried to give reasonable attention to economy. Many persons have spoken of our drawings as being of a high class of workmanship; anybody who has made many drawings knows that the good appearance of any drawing depends largely upon its lettering. Without disparaging the good lettering done by hand in our office, I would state that much of the good appearance of these drawings is due to the office boy with his printing press. For example, a title, which it would take a $5 or $6 draftsman a day to do, can be done in an hour by the printing press. Mr. Bell has not emphasized quite enough the painstaking effort expended in making a success of this printing on drawings. Those of you who are getting this result are profiting by several years of careful experience and some disappointments. Mr. Bell is now printing titles which look like well made drawing ink titles, just as opaque for photographing and blueprinting and just as resistant to the cleaning with benzine. That happy thought of getting the right kind of printer's ink and covering it with fixitif is the key to the problem.

SIDNEY W. HOAG, JR., M. M. E. N. Y.—What is that fixitif?

MR. FLINN.—It has been used by freehand artists for a long time. It is odorless and colorless. It is applied with an atomizer or a brush. If any of you picked up a drawing which has been treated in this way you would not realize that fixitif had been applied. It is only when you look at it from an angle that you can notice it at all.

MR. HOAG.—Does that fixitif make the surface waterproof after drying—impervious to the action of water?

MR. FLINN.—Reasonably so. Another distinction we have made is that between working drawings and contract drawings as to the amount of draftsman's work put upon them. A contract drawing is the first picture which we give to an intending bidder of the work to be done; therefore we thought it was worth while to make these drawings as instructive as we could, so that the estimator who has to make up the bid in a short time can quickly grasp the shape of the structure and the purpose of it; so our contract drawings have been made a little more elaborate, with a little more

shading, etc., than on the working drawings. The working drawing is for a man thoroughly familiar with the contract drawings and specifications, and so on the working drawing the amount of delineation has been reduced to a minimum. Instead of using the conventional hatching over the whole area of a cross-section on a working drawing, a little of it—just enough to serve the purpose—is all that is allowed.

In all our work we have striven for accuracy; we have not always succeeded in avoiding mistakes, and the method which Mr. Bell has described for correcting these mistakes is worthy of attention.

GARDNER L. VAN DUSEN, M. M. E. N. Y.—I should like to have Mr. Bell describe somewhat more in detail the character of the ink upon which the fixitif was used. I have used fixitif in connection with charcoal sketches and this liquid was composed of alcohol and white shellac, in about equal parts, and was applied with an atomizer. Such drawings are easily destroyed unless fixed—even a breath being sufficient to mar the effect—but the application of the fixitif gives to the sketch absolute permanency.

I have never before heard of this application of the process to mapping in connection with engineering work, but can readily see how advantageous it would be, if successful. I think, however, a more detailed description could well be made, particularly as to the character of the ink used. As I understand it, in the case in hand, some grade of printer's ink was used, not the usual drafting ink.

CLARENCE F. BELL, M. M. E. N. Y.—We tried out a good many different inks—some were fast and some were slow drying inks. We found the quick drying inks gummed on the press so fast, that while the boy was setting up the second title the ink hardened; and the slow drying inks were no good at all. The ink we use is very satisfactory and is known as "Keloe" ink. It is used very generally throughout the city by all firms that print titles. When we used the pounce and magnesia, the ink turned gray and it never got so that an elbow would not take it off. If a man was cleaning a drawing, or if he forgot that the title was printed on, his benzine rag might slip and take it off and it would have to be filled in again, and that would be the brightest part of the whole sheet; and it often meant that the whole job would have to be done over. We tried different things and finally got this fixitif We do not know what it is composed of, but think it is some kind of shellac dissolved in alcohol. We use an ordinary atomizer—one little squirt, and have found that it does absolutely resist benzine. I have tried benzine on one sample fourteen times and you cannot see any change in appearance. This sample was one of the first

made and you cannot even see the fixitif. Half was sprayed and half was put on with a brush; you can see where it was put on with the brush but not with the spray. I noticed in some of our photographs that the titles did not show up very well, and we looked at the originals and found the boy was putting fixitif on like whitewash. We told him just to spray a little on and it works very well.

MR. HOAG.—Is the fixitif put on while the ink is wet?

MR. BELL.—Yes. Before the boy prints a title, he submits a proof on paper. Then if the proof is correct, the title is printed. Now, before spraying with the fixitif, a templet, made by cutting out the printed portion of the paper proof, is placed over the title so that the spray coats only that part of the sheet on which the title has been printed, the templet protecting the rest. In about two hours, if your hand is dry, you can brush it across a new title without smearing, but it is best to leave it until the next day.

A MEMBER.—Will the gentleman kindly elaborate on the method of making blackprints from that etched plate of the blueprint?

MR. BELL.—We do not make them ourselves and formerly had two different companies making them for us. One was the Multi-Color Blackprint Company, down on Pearl Street, and the other the Lithoprint Company of Barclay Street. I do not know what their gelatine is made of as they will not tell—that is the secret of the process. The gelatine is heated, run on a zinc plate and hardens quickly. They make the blueprints on a very slow paper, leaving them exposed at times for as long as a half hour after making a print, and the lines do not get blue; then the print is laid face down on the gelatine plate and an ordinary ink roller is run over it and the plate is etched; another roller is then inked and run over the plate and only the etched portions take the ink. This is repeated for each print—re-ink, place paper on plate, run another roller over it and lift paper up and the print is made.

HERMAN A. RUGE, M. M. E. N. Y.—I wish to say a few words about the topographical signs. Frequently many different signs are used to designate the same object. The United States Government has its signs and, as Mr. Bell says, the Board adopted these signs in part. Now, in other countries, for instance, in Germany, where all engineers are trained under the same system and trained for the government service and pass their examination as government engineers, they have one uniform system of signs which is used throughout the country, and there can never be a mistake as to what is meant by a sign in topography nor in material or sections. It is the same in Switzerland and the same in France and beginning to be the same in England. The size of the drawings is governed by the drawings that have to be submitted to the government. They all have to fit in a file. Every drawing, for

instance, which a railroad submits for a concession or anything like that, has to fit in that file, which is generally in folio size. Sections are made to fold up and have to be cut to that size and at the back they are hinged with a strip of cloth and then folded to fit into that folio; and the same way they prepare longitudinal sections. In all these things there are regular regulations according to which these drawings have to be made, and I would suggest that it would be a good plan if this Society and the American Society would get together and urge the United States Government to adopt one uniform system of signs throughout the country—an American system—so that always the same signs are used for the same thing.

Then as regards the lettering, I am now working here in the United States some time, and find that you are all fond of this upright lettering, printing like you have it in the books. Now, in France, and in Germany, they use a round hand letter altogether, writing with a broad pen, and the men very soon get accustomed to it, and these plans look very fine; if you have seen them you will be astonished at their good looks and the writing is done remarkably quick. I have seen men put in big titles just as fast as you could put them in ordinary writing. They look clean and they can make figures as broad as a half inch with these pens. They have different sized pens.

Another method which may interest you is something I do not suppose any of you have ever seen. It is used by the firm of Escher & Wiess, in Switzerland, who are the greatest authorities on turbines and have made the large turbine arrangement which won the competition prize of Niagara Falls; they also made the large turbine in East India and others all over the world; and are considered experts in that branch. These people are also great constructors of steamships. About thirty years ago when I was there they delivered a large steamer to the Amazon River and the whole steamer was put together and completed in their works and then taken apart, packed and boxed and sent to the Amazon River and they put it together there, the whole steamer, and away it went up the Amazon River. Those people had a system of drawing entirely different from ours and they employed the young engineers that came from the technical schools to get a thorough knowledge in their workshops. All their drawing boards are vertical, not horizontal. The man sits before the drawing board and the T-square goes along on top on rollers and he works with his triangles. He has a shelf down here. He just pulls a string and the thing comes down lower and he shifts it this way and that way. At the same time he has no dirt of any kind on the drawing; anything that is dirt falls down right away; and they turn out the most beautiful

drawings, worked up into details that are astonishing. The only drawings I have ever seen that surpassed theirs are the Frenchman's. The Frenchman is the finest draftsman in the world. If you ever have occasion to look into the patent office at the French drawings you will see it is an entirely different article, and if you go to the architectural league, I have seen work by the graduating class of the Ecole Polytechnic in Paris exhibited there, that nothing else can touch; they were in artistic taste and workmanship, regular gems. The figures are drawn in with the least bit of coloring.

VERNON S. MOON, M. M. E. N. Y.—Referring to the method of using type, I should like to ask what kind of a press for holding type was used.

MR. BELL.—I have no photograph of the press. The plate is horizontal, about 3 ft. high, and is set in a table about 4 ft. long that we had made. The tracing is laid out flat on this table, then the chase—the term used for the casting for holding the type—is set in the press, and the boy pulls a lever down, this lever first operating the ink roller over the type and then bringing the type down on the cloth or paper, printing the title. As the cloth is always flat it does not wrinkle. We tried an ordinary press at first, but got oil spots on it, so had to get this special press. It brings the type down on the paper or cloth on which we are going to print the title or notes.

Mr. Ruge spoke about the time lost by using vertical lettering. We found that does not bother us because we do not do much of it by hand. Our sub-titles and everything are printed on with the press. Take our plan and profile sheets in contract drawings on which there is a series of notes exactly the same, except perhaps in one or two cases where some additional wording is necessary. The draftsman has been so accustomed to imitating this printed work, that words inserted by him look just the same.

EDWARD L. HARTMANN, M. M. E. N. Y.—Mr. Ruge has spoken about the method of using the round writing pen in making titles. I think that is done to quite a large extent in the shops or drafting rooms of industrial concerns of this country. I have seen a great many drawings that were made in the drafting room of the General Electric Company and other concerns that had their titles in round writing.

And then he spoke about the French people making such fine titles. I think over on the other side they spend a great deal more time than we do on their drawings. They have more time to spend; they do not do things in such a rush—they do not have to. I think that accounts for it largely—the fact that we try to do things neatly and at the same time expeditiously.

MR. HOAG.—This round writing, I think, has come and gone in this country. Some time ago, as far as my recollection goes, I think it had a try out here and a short existence—it did not take well.

ARTHUR H. PRATT, M. M. E. N. Y.—Mr. Bell has touched on one point that may bear a word or two more of comment, namely, the advantage of omitting from contract drawings a large amount of data and dimensions that can be more conveniently and profitably furnished at some future time.

The principal Board of Water Supply contracts are let on the item-unit-price basis, and the execution of many of them extends over several years. Under these circumstances, it is, of course, quite unnecessary to defer letting the contracts until full details are worked out, especially if there is reason to believe that these details will not be required in the first stages of construction. So that in such cases frequently, only the general type of structure is shown on the contract drawings, sometimes even with no dimensions whatever. The contractor having made a cubic yard price with the typical conditions in mind does not care whether the concrete is 9″ or 15″ thick, or whether there are seven or eight piers, and the designer is then left a free hand to prepare a detailed design with ample time for mature consideration.

Possibly the average designing engineer does not realize how desirable this practice is, to the great advantage of the structure contracted for and with no unfairness to its builder. The speaker has in mind a structure now being built having about 1 300 cu. yds. of concrete, which was indicated in general on the contract drawings, but did not show a single dimension. Its construction was not started until some two years after the beginning of the contract, during which time ample opportunity was available for a most carefully thought out design. No inconvenience nor expense was caused to the contractor, nor was any complaint received from him.

MR. HOAG.—Are these working drawings made after the contract is let?

MR. FLINN.—In general, the working drawings are prepared after the contracts are let. In some cases, as a matter of economy, the contract drawings are used to a large extent in making the working drawings. In a few cases the same drawing was used as a working drawing by adding dimensions purposely omitted from the contract drawing. One advantage, as Mr. Pratt has suggested, is that it does leave a freer hand for one more consideration of the problem before tying oneself down to the exact dimensions, in some matter which does not affect the bidder on a small unit price basis, but which may affect the details of design.

LEON G. GHETTI, M. M. E. N. Y.—I would like to ask how he manages to print on this printing press, sub-titles that have to be put on sections, longitudinal sections and dimensions. All that work has got to be done by hand and I think from the experience that we have had in the Department of Water Supply, Gas and Electricity we have only managed to print titles or little footnotes near the margin and not in the center of the drawing unless you fold the tracing.

MR. BELL.—We have to fold tracings at times, but the press allows folding without creasing as the fold is loose; but generally most of our work is on 20-in. by 29-in. sheets and the press is large enough to allow the printing of a sub-title in the center of a sheet of that size without folding. On larger sheets the man has to be careful.

There is one disadvantage in using the press—you can never erase the letters completely. The pressure necessary to get the ink uniform on the paper is so strong that some of the ink works into the fibre and cannot be rubbed out.

FRANK E. WINSOR, M. M. E. N. Y.—The same facilities for reproducing drawings do not exist in localities remote from the city, and more primitive methods have to be adopted. Very good results have been obtained in many instances by superimposing two tracings and making a composite blueprint. As an example: A tracing is made, upon which no title appears, showing roads, towns, railroads, streams, etc., for a given locality. Other tracings are made on the same scale, covering the same locality; upon one of which may be shown an aqueduct line with the names of the structures, etc.; upon another, the location and names of contractors' camps; upon another, the dividing lines, areas, etc., of the various watersheds. A title appears on each of the last-mentioned sheets, and the two are fitted together in the blueprint frame and prints made, thus obviating the necessity of retracing for each sheet separately the work shown on the first-mentioned tracing. The same method has been applied to progress maps and profiles, with decided economy.

THE MUNICIPAL ENGINEERS
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PROGRESS OF THE CITY TUNNEL OF THE CATSKILL AQUEDUCT.

BY WALTER E. SPEAR, M. M. E. N. Y.*

WITH DISCUSSION BY

SIDNEY W. HOAG, JR., SAMUEL C. THOMPSON, WILLIAM F. LAASE, LAZARUS WHITE, BERTRAND H. WAIT AND HERBERT M. HALE.

After months of surveys and studies by the Board of Water Supply, and after successfully undergoing a careful examination by the Board of Estimate and Apportionment, the City Tunnel, the last important link in the Catskill Aqueduct, was finally authorized and placed under contract last year, and the work is now well under way. The City Tunnel was not included in the original plan for the delivery of the Catskill supply prepared in 1905 by the Board of Water Supply; this plan was of necessity submitted before the problem of the type and location of the Catskill Aqueduct within the City could be properly studied, and provided south of Hill View Reservoir only a single pipe line for the supply of Brooklyn, Queens and Richmond Boroughs, the portions of the City then most in need. Upon investigation it soon became apparent that the tentative plan must be materially modified within the City limits in order to economically provide for the delivery of the entire Catskill supply to all portions of the City. Before requesting a modification of the original plan, the water supply needs of the City and the existing distribution system were carefully studied. The good part of a year was spent in making surveys and

* Department Engineer, Board of Water Supply.

borings in the City to determine the feasibility of the tunnel portion of the project, and during the interval between the application for the modification and the final approval of the plan, the boring work was continued to definitely fix the exact alignment and grade of the tunnel. The entire City Aqueduct project, of which the City Tunnel represents the major part, including the proposed trunk mains to be laid in the streets from the terminal shafts of the tunnel in Brooklyn to the Boroughs of Queens and Richmond, was passed upon favorably by the Board of Estimate and Apportionment of two administrations, once on December 10, 1909, and again on July 1, 1910, and was finally approved by the State Water Supply Commission on October 20, 1910.

The City Aqueduct plan thus approved provided for a pressure tunnel, entirely in the solid bed rock underlying the City, on a line nearly 18 miles in length which passes through the center of the Bronx and Manhattan Boroughs and across the East River to the downtown business section of Brooklyn Borough. Much knowledge of the geology of this locality was gained in the preliminary work on the City Tunnel, which, with other information, was presented to this Society in February of last year in an interesting paper on the geology of New York City by Dr. Charles P. Berkey, the Consulting Geologist on the City Tunnel project, and Mr. John R. Healy, Assistant Engineer, Board of Water Supply.

Location of City Aqueduct.

It will be noted that the line of the City Tunnel, as indicated on Plate 29 begins at the southerly end of Hill View Reservoir, now under construction between Jerome and Mt. Vernon Avenues in the City of Yonkers, and follows in a general way the highest ground through the Boroughs of Bronx and Manhattan. In the Bronx the tunnel is being driven within the ridge of hard gneiss of the Yonkers and Fordham series, lying between the valley of the Bronx River and that of Tibbet's Brook, following a location from Jerome Park Reservoir to the Harlem River close to that of the Old Croton Aqueduct, and crosses under Harlem River in the Inwood limestone, just south of High Bridge. After passing under the Harlem River the tunnel enters the Manhattan schist formation and is laid out under the easterly escarpment of the high ground

on the upper west side of Manhattan, beneath High Bridge, St. Nicholas and Morningside Parks and the connecting streets, to Central Park at 106th Street and Eighth Avenue; thence under Central Park, Sixth Avenue, Broadway, Fourth Avenue and the Bowery to Delancey Street, still in the Manhattan schist. In Delancey Street near the Bowery the tunnel leaves the schist and passes beneath the streets of the lower East Side, to the East River near the foot of Clinton Street in a somewhat complicated formation of Inwood limestone and Fordham gneiss. Before reaching the East River the tunnel enters a grano-diorite intrusion in the Fordham series and in this formation crosses under the East River to Bridge Street, Brooklyn; thence beneath Bridge Street and Flatbush Avenue to a terminus at Third Avenue and Schermerhorn Street. From the main line in Flatbush Avenue, a branch tunnel is to be driven through Lafayette Street to another terminal shaft in Fort Greene Park.

The somewhat irregular course of the tunnel in some portions of the City, notably on the lower East Side, is the result of the policy of locating the line beneath public streets and parks and avoiding as far as possible the expense of acquiring easements under private property. Of the 93 870 ft. of the City Tunnel, only 722 ft., or three-fourths of 1% of the entire line, is under private property where easements have had to be purchased, and out of the 24 shafts, only 4 had to be located on private lands. A straight line for the tunnel in many localities would have offered some economy in construction, but the experience in acquiring the easements for the pressure tunnel of the new Croton Aqueduct indicated that this economy would have been offset many times by the cost of acquiring rights under private lands. Furthermore, a tunnel in the rock under private property would always be exposed to injury from drill holes for elevator wells and other purposes made by persons ignorant of the location of the tunnel.

Depth of Tunnel.

As may be seen in Plate 29, throughout the Borough of the Bronx and in Manhattan from Morningside Park to the Bowery, where sound rock is found at or near the surface, the grade of the tunnel has been fixed at a depth of 200 to 300 ft., which is from 50 to 200

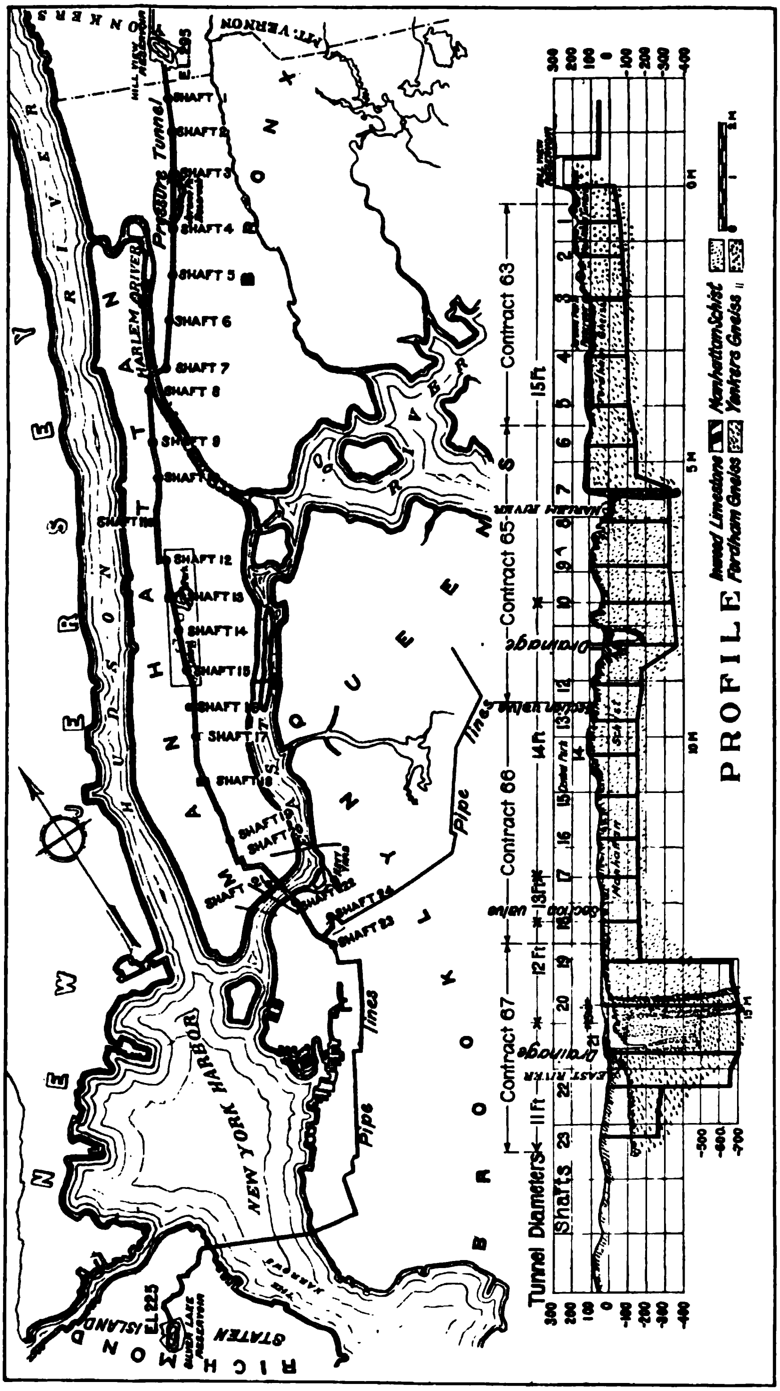

PROFILE
Contract 63
Contract 65
Contract 66
Contract 67
Tunnel Diameters
Shafts
Pressure Tunnel
HARLEM RIVER
NEW YORK HARBOR
Pipe lines
Drainage
Manhattan Schist
Yonkers Gneiss
Inwood Limestone
Fordham Gneiss
EAST RIVER
STATEN ISLAND

PLATE 29.

ft. below sea level; and the southerly portion of the tunnel in Brooklyn has a depth of but little more than 300 ft. below the surface.

At intermediate sections the tunnel has, however, been placed at a much greater depth to secure everywhere a minimum cover of 150 ft. of sound rock over the tunnel, this depth being considered necessary to insure finding a sound, tight rock in which to build the tunnel. The first depression made in the grade of the tunnel to reach sound rock is in the section from the Harlem River to Morningside Park. The erosion and decay of the limestone in the Harlem River made it necessary there to go to a depth of 330 ft. below sea level, and an equal depth was found to be required in the neighborhood of 125th Street, where the rock floor is over 200 ft. below the surface in a valley in the bed rock, which is believed to represent faulting of the schist at this point and subsequent disintegration and erosion. Another and deeper depression of the tunnel line was provided at the southerly end of Manhattan Island to carry the tunnel at a safe depth in the solid rock through the lower East Side, where in Hester and Clinton Streets the borings showed that the rock is more or less decayed to a depth of 400 to 500 ft. Under the East River the bed rock is found at a depth of only 80 to 90 ft. below the surface, but slopes off rapidly in Brooklyn to the south and east. The depth of the rock in Brooklyn fixed the distance in these directions to which the tunnel could be built; the depth of wet ground at the end of the main tunnel at Flatbush Avenue and Schermerhorn Street, which was 106 ft., represents about the limiting distance through which it is possible to sink a pneumatic caisson.

General Description of Tunnel.

The plan for a pressure tunnel in the rock under the City for the delivery of the Catskill supply was adopted because this type of construction was found to be much cheaper than steel or cast-iron mains of equivalent capacity; because the tunnel promised little or no disturbance in the highways and no interference with other uses of the streets; and because the tunnel offered greater certainty of an uninterrupted supply of water at ample pressures in the center of the City's population.

Of the 24 shafts in the City, spaced on an average about 4 000 ft. apart, 22 shafts will be completed as waterways through which

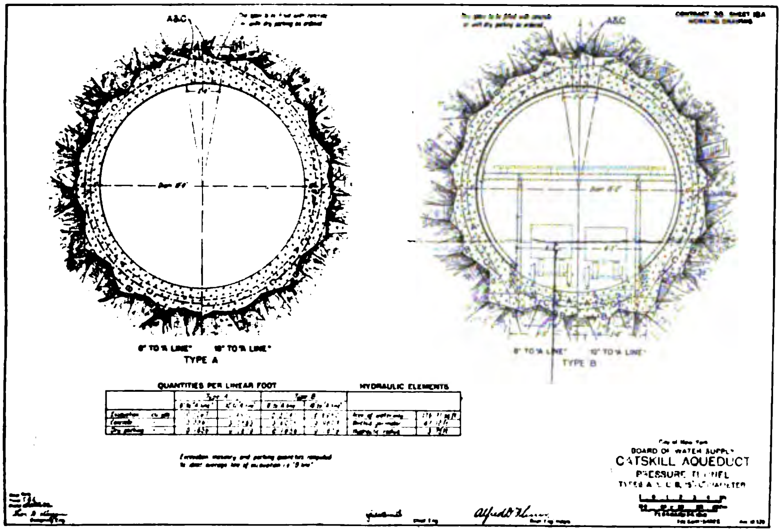


PLATE 30.—FIG. 1.

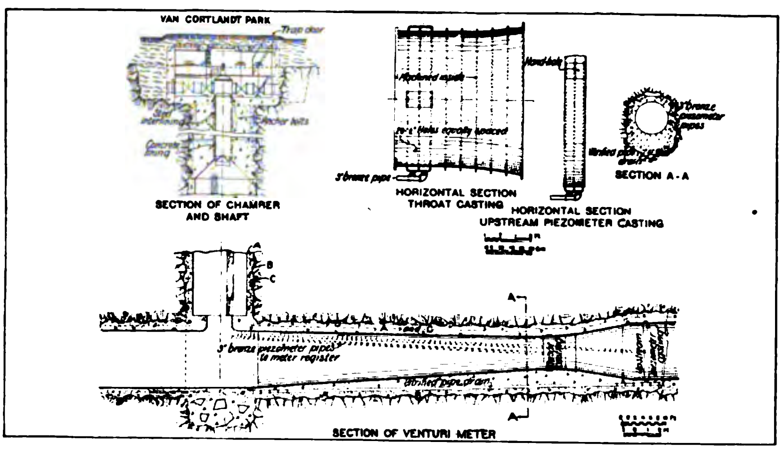


PLATE 30.—FIG. 2

the entire Catskill supply of 500 million gallons per day may be delivered, by means of suitable connections, to the City's distribution mains; one, Shaft 11 in Morningside Park, will be a drainage shaft without a waterway; and another, Shaft 1 in Van Cortlandt Park, is a construction shaft and will be plugged and refilled on the completion of the tunnel. Of the 22 waterway shafts, the two terminal shafts in Brooklyn, Shafts 23 and 24, will serve largely to supply the trunk mains 66 in. and 48 in. in size, which are being laid by the Board of Water Supply from these shafts to the Boroughs of Brooklyn, Queens and Richmond and two shafts, Shaft 3, at Jerome Park Reservoir, and Shaft 10 at 135th Street, will have connection of ample size by which to deliver large volumes of water to the Croton system at Jerome Park Reservoir and the 135th Street gatehouse respectively. The other waterway shafts will have connections not exceeding 30-in. in diameter with the nearby distribution mains for the supply of the districts in which they are situated.

The finished interior diameter of the tunnel will be 15 ft. from Hillview Reservoir to Shaft 10 at 135th Street, a distance of 7.7 miles; 14 ft. in diameter from this point to Shaft 17 at Sixth Avenue and 41st Street, a further distance of 5.0 miles; at Shaft 17 the diameter will be further decreased to 13 ft. and at Shaft 18 at Broadway and 24th Street, 0.9 mile beyond Shaft 17, to 12 ft. This size will be carried to a point 1 500 ft. south of Shaft 20, or about Orchard and Hester Streets, a distance of 2.0 miles. The remainder of the tunnel to Brooklyn, aggregating 2.5 miles, will be 11.0 ft. in diameter.

The general design of the tunnel differs but little except in size from the pressure tunnel constructed on other portions of the Catskill Aqueduct, one of which, the Rondout Siphon, was described to you in May, 1911, by Mr. Lazarus White, who now has charge of the southerly division of the City Tunnel. Typical sections of the 15-ft. diameter tunnel, showing the lines to which the rock is to be excavated and the thickness of the concrete lining, are shown on Plate 30, Fig. 1. Generally the type "A" section is being adopted for all sizes of tunnel and the thickness of the lining in shallower portions of the tunnel will not probably be less than 10 in. to the "A" line, and in the deeper sections perhaps 12 to 14. One of the features of the City Tunnel is the Venturi meter which is to be placed in

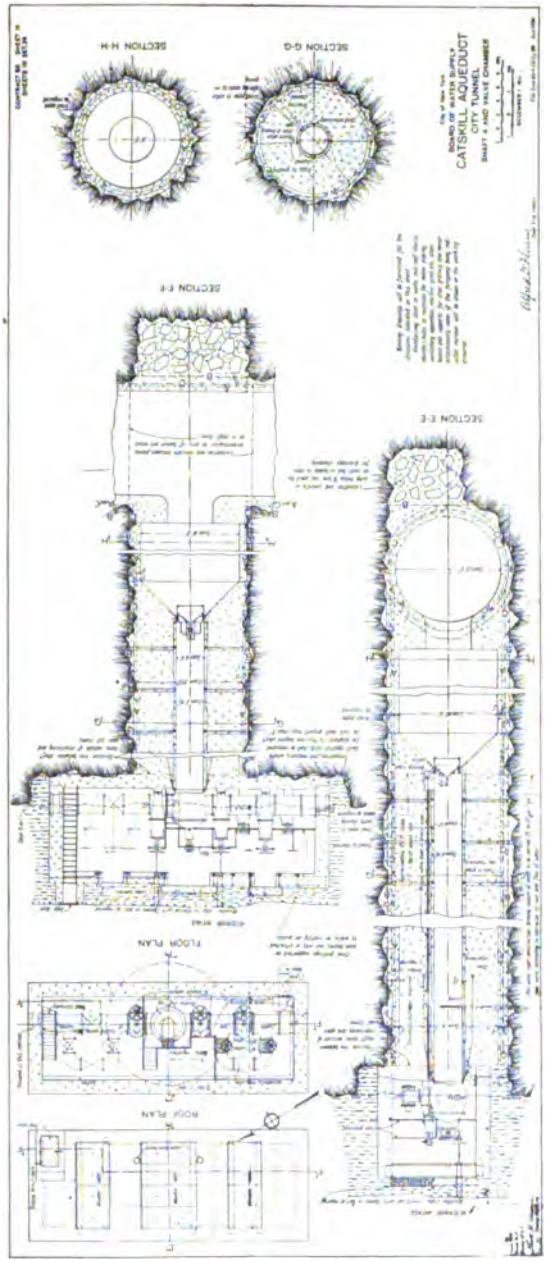

SECTION H-H
SECTION G-G
SECTION F-F
SECTION E-E
FLOOR PLAN
ROOF PLAN
BOARD OF WATER SUPPLY
CATSKILL AQUEDUCT
CITY TUNNEL

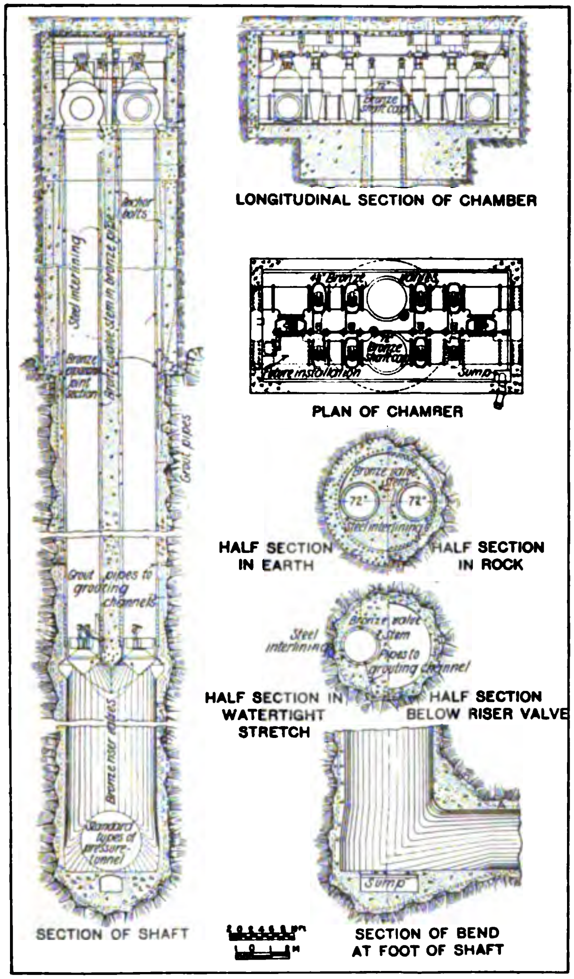
PLATE 31.

the tunnel just above Shaft 2, the first waterway shaft, to measure the entire delivery to the City. The general design of the meter is shown, Plate 30, Fig. 2.

The City Tunnel differs from other pressure tunnels of the Catskill Aqueduct in the waterway shafts by which connections are provided with the distribution mains. Furthermore, with the exception of two section valve shafts, 13 and 18, to be hereinafter dedescribed, all shafts of the City Tunnel are circular instead of rectangular as are most of the shafts in other tunnels of the Catskill system where the general American practice was followed. A circular waterway shaft, typical of Shafts 2, 4, 5, 6, 7, 9, 12, 14, 15, 16, 19 and 22, is shown in Plate 31. The lower portion of the shaft is designed to be lined with concrete, with a finished diameter of 14 ft. from the tunnel to an elevation roughly 100 ft. below the top of sound rock. From this point to the surface or more properly to the bottom of the valve chamber just below the surface at the top of the shaft, a 48-in. concrete-lined steel riser pipe is to be concreted into the shaft. This riser pipe will be capped by a bronze tee, from which will be taken each way a 30-in. connection, to which will be attached two 30-in. valves in tandem, one a service valve, the other a bronze valve attached to the bronze tee which is to be used when the first is being replaced or repaired. At the bottom of this riser pipe there will also be a special valve controlled from the valve chamber or from the surface above the chamber, which is designed to be used only in emergencies to cut off the flow through the riser when the other valves above are out of order.

The other waterway shafts have two risers, Shafts 3, 8, 10, 13, 17, 18 and 20, of the same size as that described, 48 in. in diameter, and the terminal shafts, 23 and 24, 2 risers 72 in. inside diameter. The size of Shafts 23 and 24 are proportionally larger below the risers, being 16 ft. in diameter. The design of one of the terminal shafts, 24, is shown in Plate 32. Each of these terminal shafts has sufficient capacity to deliver the full flow in the 11-ft. tunnel should, by any chance, any accident occur to the other.

At the so-called section valve shafts, 13 and 18, valves or gates are to be built in the tunnel to permit of cutting off the sections of the tunnel north or south of these shafts. These shafts are


LONGITUDINAL SECTION OF CHAMBER
PLAN OF CHAMBER
Sump
HALF SECTION IN EARTH
HALF SECTION IN ROCK
Bronze valve stem
Steel interlining
HALF SECTION IN WATERTIGHT STRETCH
HALF SECTION BELOW RISER VALVE
Steel interlining
Pipes to grouting channel
SECTION OF SHAFT
Anchor bolts
Steel interlining
Grout pipes
Grout pipes to grouting channels
Bronze riser pipes
SECTION OF BEND AT FOOT OF SHAFT
Sump

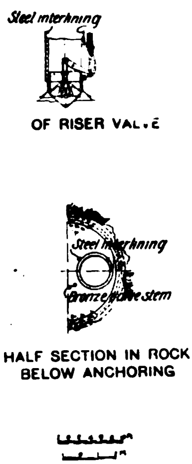

Steel interlining
OF RISER VALVE
Steel interlining
HALF SECTION IN ROCK BELOW ANCHORING

PLATE 82.

roughly rectangular in shape and in addition to a central well giving access to the section valve at tunnel grade, there are to be two risers 48 in. in diameter which are connected to the tunnel either side of the section valve, as shown on Plate 33.

One of the drainage shafts, Shaft 11, has no riser, as already noted, and is almost identical with similar shafts of the other pressure tunnels of the Catskill Aqueduct. This shaft is located on a lateral drift from the main tunnel, about 75 ft. in length, and will be equipped to drain the northerly portion of the tunnel from Hill View Reservoir to Central Park. The other drainage shaft, 21, will be likewise constructed to drain the southerly portion of the tunnel, but this shaft has, in addition to the drainage feature, a 48-in. riser through which water may be delivered to the distribution system as at other waterway shafts.

Capacity of City Tunnel.

The City Tunnel is designed to carry with a reasonable loss of head the full capacity of the Catskill Aqueduct, 500 mil. gal. per day from Hill View Reservoir, and to distribute this amount as required to the various shafts along the line. With a pressure gradient 295 ft. above sea level at Hill View Reservoir, the tunnel will deliver this amount of water plus an allowance of 15% for the period of maximum demand at a pressure in Manhattan which will never be less than that corresponding to an elevation of 260 ft. above sea level and will deliver a supply of 250 mil. gal. per day to Brooklyn, at a pressure equivalent to a head of 250 ft. above sea level.

Contracts for Tunnel.

The City Tunnel was divided into 4 contracts, as indicated on Plate 29.

Contract 63: City line to Burnside and Aqueduct Avenues, University Heights in the Borough of the Bronx, comprising 21 270 ft. of 15-ft. diameter tunnel and 5 shallow shafts (218 to 246 ft.).

Contract 65: University Heights in the Bronx to Central Park at 100th Street, Manhattan Borough, comprising 28 300 ft. of tunnel 15 and 14 ft. in diameter and 7 shafts, of

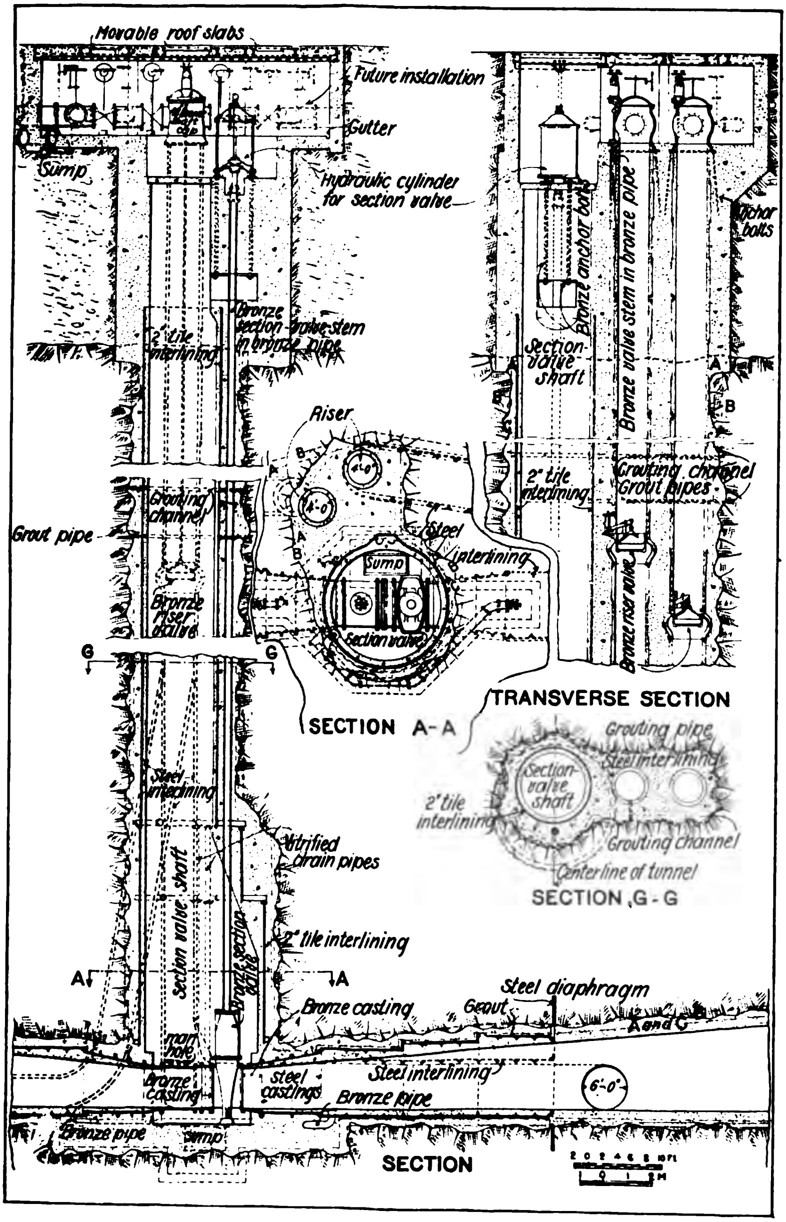

Movable roof slabs
Future installation
Gutter
Sump
Hydraulic cylinder for section valve
Bronze section valve stem in bronze pipe
2" tile interlining
Grouting channel
Grout pipe
Bronze riser valve
Riser
Steel interlining
Sump
Section valve
SECTION A-A
Bronze anchor bolt
Bronze valve stem in bronze pipe
Section valve shaft
Anchor bolts
Grouting channel
Grout pipes
Bronze riser valve
TRANSVERSE SECTION
Grouting pipe
Steel interlining
Section valve shaft
2" tile interlining
Grouting channel
Centerline of tunnel
SECTION G-G
Steel interlining
Vitrified drain pipes
Section valve shaft
Bronze section valve
2" tile interlining
Steel diaphragm
Bronze casting
Grout
man hole
Bronze casting
Steel castings
Steel interlining
Bronze pipe
6'-0"
Bronze pipe
Sump
SECTION

PLATE 33.

which 2 are shallow (262 and 278 ft.) and 5 are moderately deep (352 to 478 ft.).

Contract 66: Central Park at West 100th Street to Union Square, Broadway and 14th Street, Manhattan Borough, comprising 23 140 ft. of tunnel, 14, 13 and 12 ft. in diameter and 6 shallow shafts (205 to 253 ft.).

Contract 67: Union Square, Manhattan Borough, to the terminal shafts in Brooklyn Borough, at Flatbush and Third Avenues, and at Ft. Greene Park, comprising 21 160 ft. of tunnel 12 and 11 ft. in diameter and 6 shafts of which 2 are shallow (318 and 329 ft.) and 4 are deep (710 to 752 ft.).

Bids were opened on these contracts on May 16, 1911, and awards made to the lowest bidders, as follows:

Contract.	Contractor to whom awarded.	Amount of bid based on engineers' estimate of quantities.	Date of award.	Date of notice to begin work.
63......	Mason & Hanger Co.......	$8 709 872	June 1, 1911.	June 9, 1911.
65.....	Pittsburg Contracting Company...............	5 590 225	June 7, 1911.	June 15, 1911.
66......	Grant, Smith & Co., and Locher..................	4 512 605	June 7, 1911.	June 15, 1911
67......	Holbrook, Cabot & Rollins Corp., T. B. Bryson and George B. Fry...........	5 272 435	June 1. 1911.	June 8. 1911.

You will note that the cost of the tunnel, including the shafts based on the amount of these contracts, gives the following unit cost per linear foot of tunnel:

Contract 63..$174.
" 65.. 197.
" 66.. 195.
" 67.. 249.

These prices are generally higher than those on similar pressure tunnels on the Catskill Aqueduct, which run from $105 to $180 per foot and represent not only the additional cost of the complicated waterways, the smaller tunnels in the southerly sections, and in the case of Contract 67, the expensive pneumatic caisson work, but also the increased cost and delay in doing work in the City, which will be pointed out later.

FIG. 1.

FIG 2.

The contractors began to assemble plant early in June, as soon as they received notice to begin work, and with the exception of Shaft 16 on Contract 66 and Shafts 21 and 23 on Contract 67, where possession of the necessary land was delayed by condemnation proceedings, work at all shafts was well under way by the last of July. The site of Shaft 20 at Delancey and Eldridge Streets was purchased at private sale and but little delay occurred. The commissioners of condemnation who were appointed to appraise the City Aqueduct real estate filed their oaths of office on August 7, 1911, and after a necessary interval for surveys and inspection, the contractors had possession of all shaft sites early in September.

Sinking Shafts in Earth.

The sinking of the shafts in earth in the three northerly contracts, 63, 65 and 66, offered no unusual difficulties, since the rock was generally found at or near the surface or could be reached by ordinary open cut methods. Before beginning shaft-sinking, the contractors in most instances excavated and sheeted the large chambers at the top of the shafts which are from 20 to 30 ft. wide, 30 to 50 ft. long, and have a depth of 15 to 40 ft. below the surface. Stiff-legged derricks were set up for the excavation of these chambers, and were also used in sinking of the upper portion of the shafts. Plate 34, Fig. 1, shows the sheeting and timber in the chamber at Shaft 17 which is typical of most of the chamber excavations. The steel sheeting and timber bents which were put in at Shaft 5 below the chamber excavation to reach the rock is seen in Plate 34, Fig. 2. Special care was exercised at this shaft to prevent any loss of ground, because the old Croton Aqueduct is on an earth embankment only 20 ft. away. No settlement occurred about the excavation and after the concrete lining was placed the steel sheeting was removed and grout forced into the ground outside of the concrete walls. Steel sheeting was also employed in the earth portion of Shaft 18, where the rock was 30 to 40 ft. below the surface.

Pneumatic Caissons.

At the shafts of Contract 67 the rock floor is covered by some depths of generally pervious earth, of which 30 to 100 ft. are below the water table, and the shafts are situated in localities where serious damage might have resulted from attempting to reach the rock

of the excavation, but as the pressure increased one was reserved entirely for the men and they were taken in and out in a bucket. The general dimensions and weights of each caisson, the maximum air pressures used and the frictional resistances estimated at the times of movement of the caisson when bottom free and clear are shown in the following table:

Caisson shaft.	Outside diameter, feet.	Thickness of concrete wall, feet.	Total depth of caisson, from bottom chamber, feet.	Weight of caisson-locks, etc., tons.	Weight of maximum load, tons.	Maximum pressure at which sealed. Pounds per sq. in.	Estimated friction and penetration resistance. Lbs. per sq. ft., making allowance for air pressure.
19.....	19.3	2.0	46.1	466	700	17	300 to 400
20.....	19.3	2.0	102.0	1 050	2 100	39	630
22.....	19.3	2.0	96.0	978	2 470	28	680 to 736
23.....	24.0	3.0	117.6	2 823	4 612	45	870 to 1 450
24.....	24.0	3.0	95.4	1 780	4 046	29.5	945 to 1 685

You will note that the frictional resistance on these circular caissons ranged from 300 lb. to 1 685 lb. per sq. ft. This wide range is probably to be explained by the difference in the sizes of caissons and in the material encountered, by slight irregularities in some of the casings, the depth of penetration of the cutting edge below the excavation in the working chamber and the straightness with which the caisson was sunk.

Good progress was made in sinking the caissons in earth. The average advance of the 5 circular caissons was $8\frac{3}{4}$ ft. per 24 hours; the record progress was made at Shaft 20, where the caisson was dropped 10.9 ft. in 24 hours.

The method of sealing these concrete caissons into the rock is by far the most interesting feature of the work and the most difficult. The work had to be done under the highest pressure and on the average only 8 cu. yds. of rock could be excavated daily; including the time from the beginning of the excavation of the rock to taking off the pressure the sealing took about three weeks. The method of sealing is shown in detail on Plate 38. When the rock had been excavated to the required depth, which was fixed at 5 ft. below the lowest point of the rock at the cutting edge, the bottom was leveled up, a bench of concrete was placed a foot thick around the shaft with wood blocks set under the cutting edge to receive the shock of the dropping caisson, and a collar of 1:2 mortar carried up to 3 ft. above this. In this collar and passing through the bench at least six 2-in. grout pipes were set as shown, communicating with the three horizontal grooves formed in the ring for the purpose of insuring a free circulation of the grout around the caisson. The caisson was lowered to the bench after the cement had set, a ring

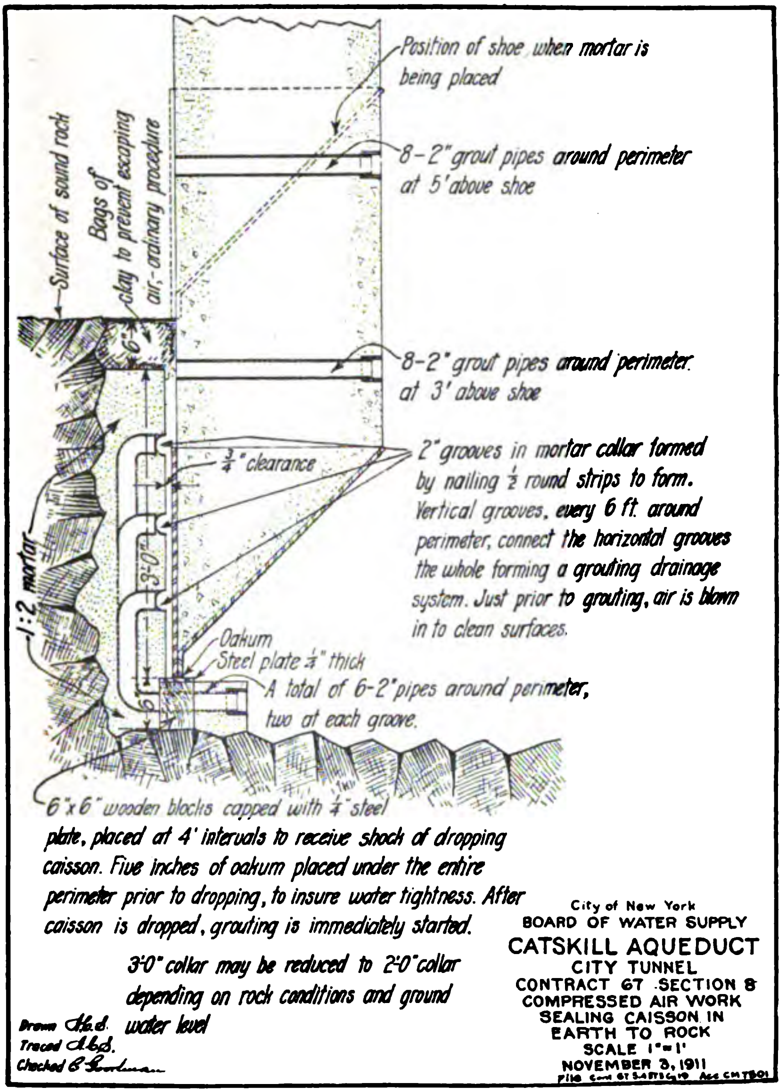

Position of shoe when mortar is being placed
8-2" grout pipes around perimeter at 5' above shoe
8-2" grout pipes around perimeter at 3' above shoe
Surface of sound rock
Bags of clay to prevent escaping air-ordinary procedure
6"
3/4" clearance
3'-0"
1:2 mortar
2" grooves in mortar collar formed by nailing 1/2 round strips to form. Vertical grooves, every 6 ft. around perimeter, connect the horizontal grooves the whole forming a grouting drainage system. Just prior to grouting, air is blown in to clean surfaces.
Oakum
Steel plate 1/4" thick
A total of 6-2" pipes around perimeter, two at each groove.
6"x6" wooden blocks capped with 1/4" steel plate, placed at 4' intervals to receive shock of dropping caisson. Five inches of oakum placed under the entire perimeter prior to dropping, to insure water tightness. After caisson is dropped, grouting is immediately started.
3'-0" collar may be reduced to 2'-0" collar depending on rock conditions and ground water level
City of New York
BOARD OF WATER SUPPLY
CATSKILL AQUEDUCT
CITY TUNNEL
CONTRACT 67 SECTION 8
COMPRESSED AIR WORK
SEALING CAISSON IN EARTH TO ROCK
SCALE 1"=1'
NOVEMBER 3, 1911

PLATE 88.

of oakum being placed to make a temporary seal and the space between the outer wall of the cutting edge and the ring was grouted with neat cement. Other grout pipes through the walls of the caisson were then filled and after the expiration of something like 12 hours the pressure was taken off. On the average 3 days were required to place the concrete bench and collar, and to lower and grout the caisson. In the case of one caisson, that at Shaft 20, the leakage through the seal when the pressure was removed was only 10 gallons per 24 hours, and the maximum leakage at Shaft 23, the deepest earth shaft, was only 7 gallons per minute, which was subsequently grouted off. The mass of those loaded caissons was such that it was exceedingly difficult to keep them plumb, and more difficult to right them when once out of perpendicular. The maximum deviation from the perpendicular on the length of the caissons was about 8 in. in case of caisson at Shaft 24, which was 95 ft. deep, while the caisson at Shaft 20, 102 ft. long, went down practically plumb, as shown below:

Shaft.	Outside Diameter of caisson, feet.	Total depth of caisson, feet.	Amount, in Inches, by which Caisson was out of Plumb when Sealed.	
			In total length.	Per foot of length.
19....	19.3	46.1	1.00	0.022
20....	19.3	102.0	1.00	0.010
22....	19.3	96.0	7.37	0.074
23....	24.0	117.6	6.72	0.055
24....	24.0	95.4	7.90	0.075

Shaft 21 differs materially from the other five shafts of Contract 67, because of the support which it was necessary to provide for the superstructure over the drainage chamber at the top of the shaft; instead of a single caisson to rock for the shaft and a number of smaller caissons to carry the superstructure the contractor chose the alternative permitted under the contract of sinking and excavating to rock four rectangular concrete filled wooden caissons 37 ft. to 43 ft. in length, and 5 ft. thick, on which the superstructure will be built.

These caissons, with half-moon closures, are shown in plan on Plate 39. The rock here was only 30 to 40 ft. below the surface and these caissons, which were made 37 ft. high, were sunk without incident. The frictional resistance was about 1 200 lb. per sq. ft.

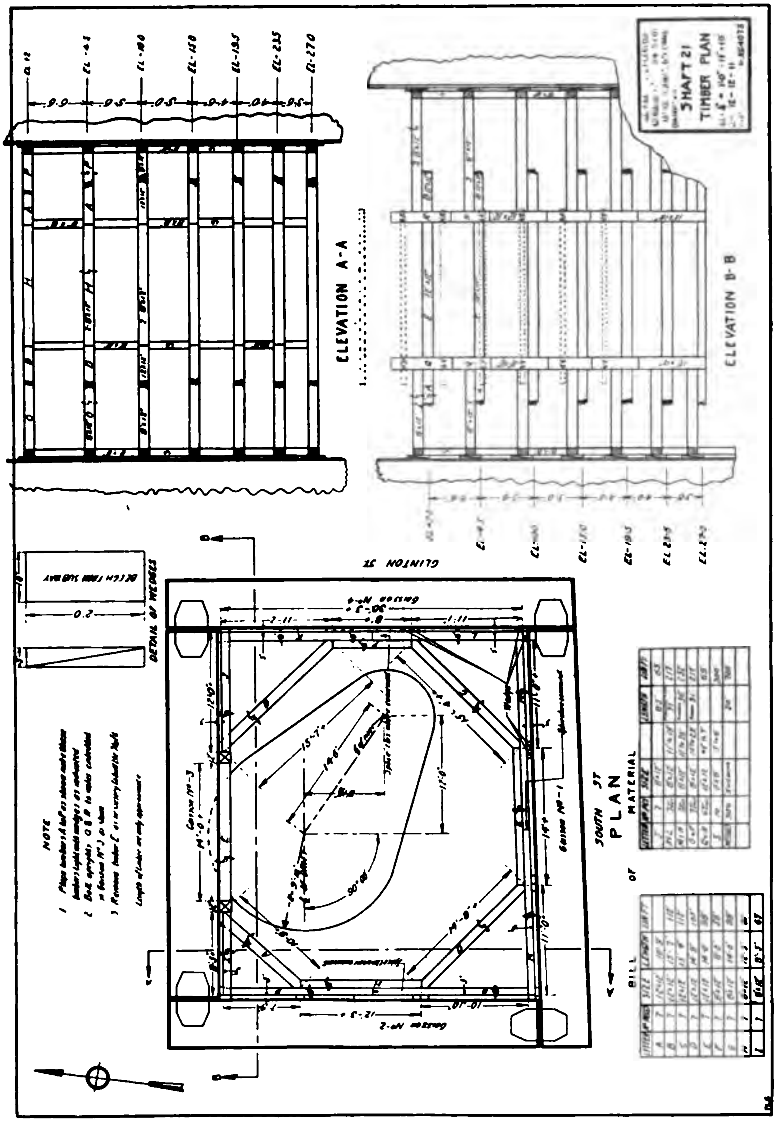

SHAFT 21
TIMBER PLAN
ELEVATION A-A
ELEVATION B-B
PLAN
OF
BILL
MATERIAL
CLINTON ST
SOUTH ST
NOTE
DETAIL OF WEDGES

PLATE 89.

The grano-diorite, when uncovered, was found to be hard but seamy; considerable water entered through the bottom of the excavation and came in at the corners of the caissons where not tightly sealed on the rock. Some leakage also entered the upper portion of the shaft, as it was excavated, and it was necessary to put in a temporary lining in the shaft, place a blanket of concrete over the entire bottom of the excavation within the wall caissons, and grout off the leakage.

Shafts in Rock.

The sinking of the shafts in rock has been carried on during the entire 24 hours of each working day, with 3 shifts of men. The force employed at a well-organized shaft is shown below. This is a circular shaft, in Manhattan schist, 18 ft. in diameter.

General:	
Superintendent	2
Timekeeper	1
Storekeeper	2
Watchman	2
Magazine tender	2
Foreman	1
Rigger	4
Carpenter	4
Laborer	4
Bottom of Shaft:	
Shift boss	3
Drill runners	9
Muckers	19
Top of Shaft:	
Foreman	2
Compressor engineer	3
Blacksmith	3
Blacksmith's helper	3
Electrician	3
Top man	4
Signalman	3
Hoist runner	3
Pipeman	6

Muck Bins:

Team and driver	4
Laborer	1
Total	88

Practically all of the drilling was done by this organization during the 12 midnight to 8 A. M. shift; 8 cut holes and one center hole were shot about 7:30 A. M.; after mucking out, 14 relief holes were fired, about noon, and, after mucking, the 20 rim holes were fired, about 4:30 P. M. Six Ingersoll Rotating Hammer drills were used; the cut holes were drilled 8 ft. in depth, the relief holes 7.5, and the rim holes 7.0 ft. 310 ft. of holes were drilled per round. An average advance of 6.0 ft. was made each round, and 1.9 lb. of 60% dynamite per cu. yd. were used.

On Plate 40 is shown the arrangement of drill holes in the shafts of Contract 66. This arrangement is practically the same as that followed in the shafts of the other contracts. You will note that 30 to 40 holes were drilled in one round in the circular shafts and 43 to 46 in rectangular shafts; 4 to 6 ft. were pulled at each advance. The amount of dynamite used at the shafts in the built-up portions of the city averaged from 1.5 to 2 lb. per cu. yd. excavated. At some shafts, located at a safe distance from buildings, where the rock was harder, 3 to 3½ lb. of dynamite were used. Both 40% and 60% dynamite were used.

Records of 25 to 30 ft. per week have been frequently made in the shafts of the City Tunnel, but the best record thus far made was at Shaft 10, where an advance of 37 ft. per week was made. The progress per month has not approached the record made at the other tunnels of the Catskill Aqueduct, principally because of the short depths of the shafts thus far completed, which did not permit of effecting the necessary organization, and because of the frequent interruptions and the consequent disorganization of the drilling and mucking force resulting from the interruptions necessary to concrete the shaft at intervals of 100 ft. The best month's work thus far recorded was 108 ft., which was done at Shafts 8 and 10 of the Pittsburg Contracting Company's contract, though a somewhat better performance was made at Shaft 20, one of the shafts

of Holbrook, Cabot & Rollins Corporation contract, where, in addition to 100 ft. of shaft sinking, 65 ft. of the shaft was concreted in a month. A record of 96 ft. in three weeks was made at Shaft 14 by the Dravo Contracting Company, who were sinking this shaft for Grant, Smith & Company and Locher.

The progress that has been made in shaft sinking to date is summarized in the following table:

PROGRESS IN EXCAVATING ROCK SHAFTS.

Contract No.	Shaft No.	Average speed, in feet per month, including time of concreting.	Maximum weekly progress, in feet.	Maximum monthly progress, in feet.
63........	1	37.8	23	59
	2	48.3	22	62
	3	52.0	33	75
	4	47.0	32	80
	5	51.3	19	62
65........	6	40.8	20	70
	7	47.0	25	75
	8	97.8	32	108
	9	45.0	22	78
	10	70.8	37	108
	11	57.2	26	80
	12	48.0	21	52
66........	13	40.0	26	55
	14	86.0	33	100
	15	68.0	32	95
	16	76.0	28	87
	17	57.8	24	65
	18	51.0	15	53
67........	19	78.0	30	75
	20	100.0	35	100
	21	58.8	25	78
	22	73.0	27	78
	23	82.0*	21	..
	24	56.9	24	61

* Two weeks only.

The rock shafts have been, on the whole, dry, and the rock, generally, sound. The rock, however, has ordinarily a dip in excess of 45°, and shows evidence in places of much folding and slipping. At Shaft 4, at the lower end of Jerome Park Reservoir, bad ground was encountered not far above the tunnel grade. Fifty holes were drilled at the bottom of the excavation, and over 900 bags of neat cement were used in grouting, before the water was cut off. When the shaft was finally sunk through the wet ground it was found that the rock was badly broken, and there was one seam in which the rock had so much disintegrated that there was little left but sand.

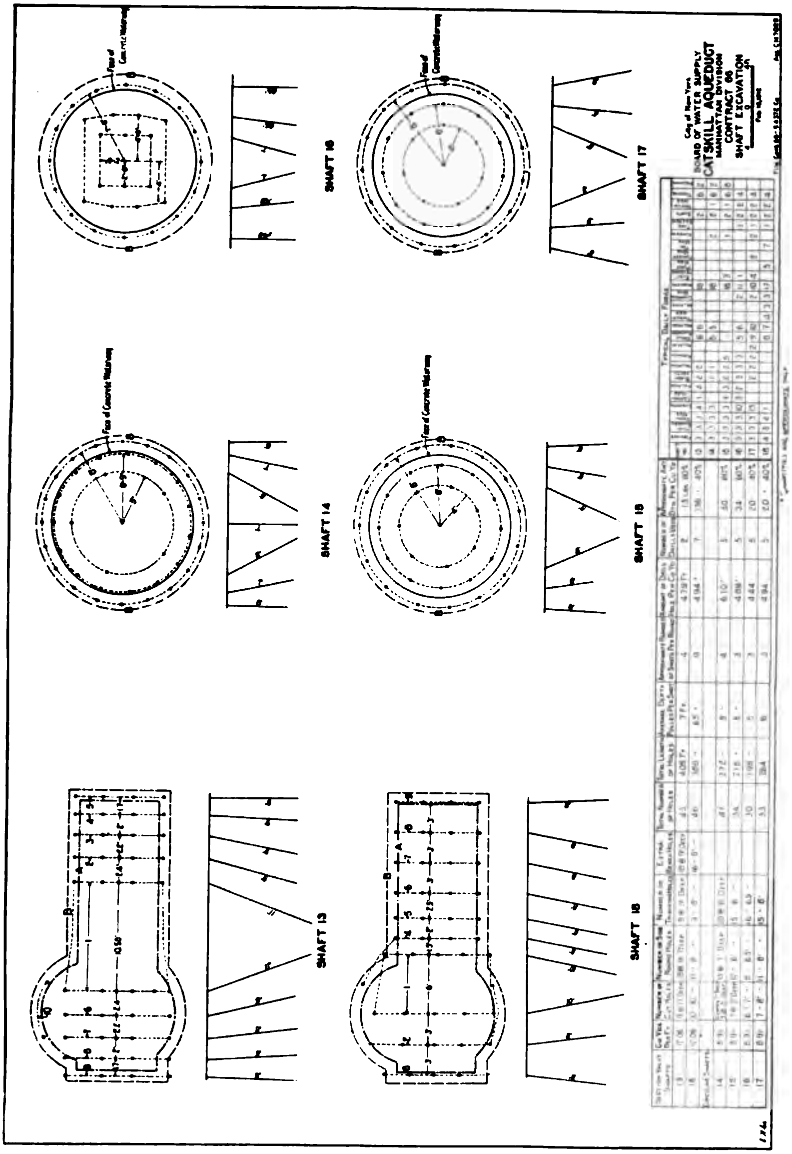

SHAFT 13
SHAFT 14
SHAFT 15
SHAFT 16
SHAFT 17
SHAFT 18
Face of Concrete Waterway
City of New York
BOARD OF WATER SUPPLY
CATSKILL AQUEDUCT
MANHATTAN DIVISION
CONTRACT 66
SHAFT EXCAVATION
TYPICAL DRILL FORMS

PLATE 40.

This, and the other thin seams which were filled with the same material, did not take the grout readily, and this fact accounts for the large number of holes that were necessary. After the shaft was excavated some 10 ft. below the bad ground, a thick reinforced concrete lining was placed and the ground behind filled with grout. Somewhat similar ground was found at Shaft 24, in Fort Greene Park, Brooklyn, and the grouting appears to have been equally successful.

As stated above, the placing of the concrete lining has interfered somewhat with rapid progress on the City Tunnel shafts; in most shafts, however, the rock was such that some support would have been necessary at frequent intervals, so that time lost in concreting was more apparent than real.

The concrete lining of the lower portions of the shafts below the river valves represented the finished lining of the final waterway. Only the irregular section valve shafts, 13 and 18, were timbered. The experience on this work has demonstrated the advantages of the concrete lining; it gives no trouble after once in place, and effectually cuts off the inflow of water to the shaft. The method of making a closure in the concrete lining is shown in Plate 41.

Progress on Tunnel.

The first shot was taken from the tunnel heading at Shaft 14 on December 6, 1911, and the tunnels were started at other shafts shortly after that date. At present, 16 of the 24 shafts have been completed to tunnel grade, and at some of the shafts the tunnels are well under way. Ordinarily, from two to six weeks has been required after the completion of the shaft to change over equipment and install cages in readiness for tunnel driving. The progress on the tunnels, even where the headings are at some distance from the shaft, has not yet equalled the record made on other parts of the Catskill work. A number of circumstances have contributed to this comparatively small progress, such as are necessarily incident to the execution of shaft and tunnel excavation through the heart of our great city.

The storage of the amount of dynamite required for a tunnel of the size of the City Tunnel, constructed in the midst of congested business and residential districts, has presented a serious

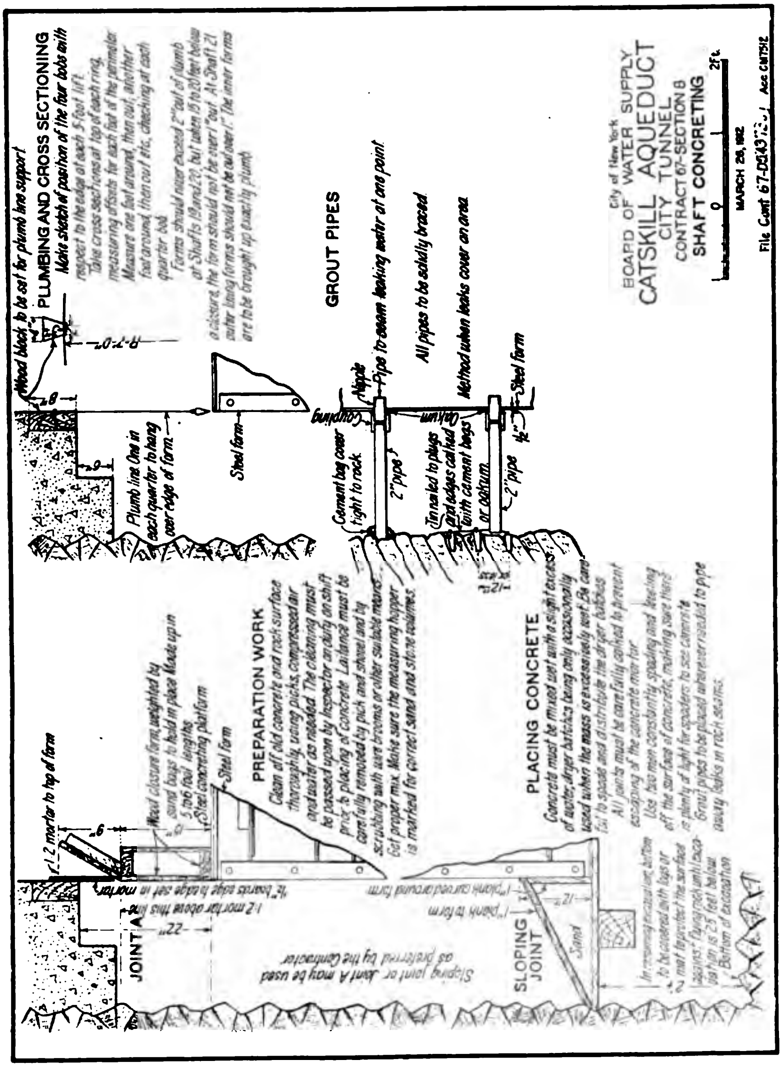

PLUMBING AND CROSS SECTIONING
GROUT PIPES
PREPARATION WORK
PLACING CONCRETE
JOINT A
SLOPING JOINT
Steel form
City of New York
BOARD OF WATER SUPPLY
CATSKILL AQUEDUCT
CITY TUNNEL
CONTRACT 67-SECTION 8
SHAFT CONCRETING
MARCH 28, 1912

PLATE 41.

problem for those having the responsibility in such matters. Only 150 to 200 pounds of powder were allowed to be stored during the shaft-sinking period, and only 400 pounds are now permitted temporarily in the surface magazines. The Municipal Explosives Commission has approved underground magazines excavated in the rock at the end of a drift 75 ft. in length, the entrance to which from the tunnel will not be less than 100 ft. from the foot of the shaft. This magazine is to have a heavy door, hung in a concrete bulkhead, at the entrance to the magazine drift, which is designed to close when an explosion occurs in the magazine and prevent the escape of the gases of combustion in the magazine and minimize the rush of air up the shaft. The design of this magazine has been worked out by the engineers of the City Aqueduct Department and is based on French and German practice. A number of these magazines are under construction, and one of them, that at Shaft 18, is practically finished.

Disposal of Excavation.

The contractors on the lower sections of the City Tunnel have encountered no more serious problem than that of disposing of the materials excavated from the shafts and tunnels. At the first four shafts, 1 to 4, inclusive, it was possible to find areas adjacent to or near the shaft sites on which the earth and rock could be spoiled at comparatively little expense; but at the other shafts it has been necessary to haul everything to the waterfront, or other points of disposal at some distance from the shaft. On Contract 65, through an arrangement with the Park Department, a large amount of the excavation is being dumped along the North River near 129th Street, to fill an area on the river front that is being reclaimed for a park. A portion of the excavation on Contract 66 has gone to make a fill at the foot of West 79th Street, but more of it is going to the docks, to be carried to sea, and much of that on Contract 67 is being similarly disposed of.

Plant Layouts.

The amount of land available to the contractors about the shafts of the City Tunnel was necessarily limited in some localities to hardly 5 000 sq. ft., and it is interesting to see how the contractors have arranged their plants on such small spaces. Plate 42 shows

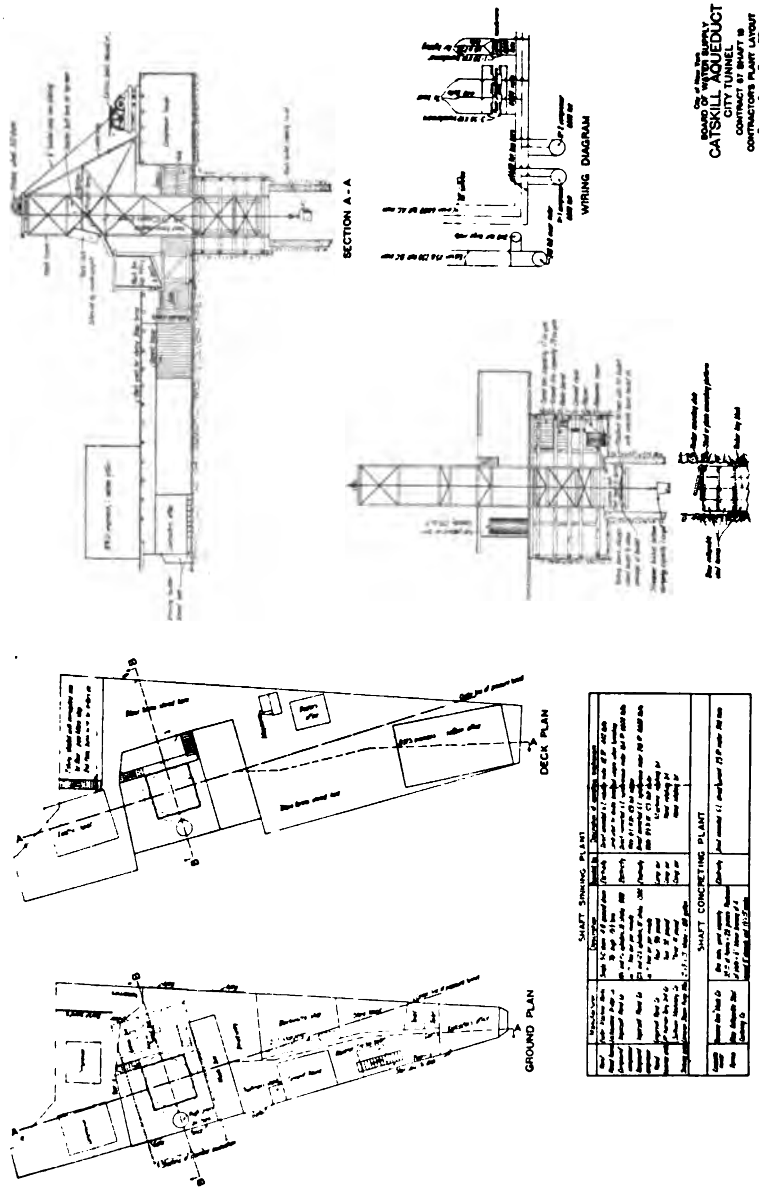

SECTION A-A
WIRING DIAGRAM
SECTION B-B
DECK PLAN
GROUND PLAN
SHAFT SINKING PLANT
SHAFT CONCRETING PLANT
BOARD OF WATER SUPPLY
CATSKILL AQUEDUCT
CITY TUNNEL
CONTRACTOR'S PLANT LAYOUT

PLATE 42.

the arrangement of the contractor's plant at Shaft 19 and the Bowery, during the period of sinking this shaft in rock. This is a good example of a small space well utilized. Referring to this plant, you will see that the compressors, blacksmith shop, cement shed, store house, contractor's office, and drives occupy the ground level, while on the deck above are the hoists, repair shops, shelter for men, dynamite magazine, and engineer's and doctor's office, and open storage room for forms and other equipment. The equipment for sinking this shaft and placing the concrete lining is tabulated below:

SHAFT-SINKING PLANT.

	Manufacturer.	Size.	Operating mechanism.
Hoist........	Exeter Machine Works..	Single, 5 ft. diam. by 4 ft. 6 in. geared drum....	Direct connected G. E. induction motor; 112 h.p.; 440 volts.
Headframe..	Lackawanna Bridge Co..................	76 ft. high 15½ tons	Constructed for double balanced cages when tunneling.
Compound compressor	Ingersoll-Rand Co....	18½ in. and 11½ in. cylinders, 16 in. stroke, 900 cu. ft. free air per minute..............	Direct connected G. E. synchronous motor: 164 h. p.; 6 600 volts: with 6½ kw.—125-volt exciter.
Compound compressor	Ingersoll-Rand Co....	21½ in. and 12½ in. cylinders, 18 in. stroke, 1 800 cu. ft. free air per minute.....	Direct connected G. E. synchronous motor; 215 h. p.; 6 600 volts, with 9½ kw.- 125-volt exciter.

	Manufacturer.	Number and size.	Operating mechanism.
Hard hammer drills..	Ingersoll-Rand Co.....	Four 96 lb............	Machine rotating bit.
	McKiernan Terry Drill Co.	Two 52 lb..............	Hand rotating bit.
	Sullivan Machinery Company..........	Three 41 lb............	Hand rotating bit.
Sinking pump.....	Cameron Steam Pump Works......	12 x 5 x 13 in. stroke, 100 gallons.	

SHAFT CONCRETING PLANT.

Concrete mixer..	Ransome Concrete Machine Co........	1 cu. yd. capacity....	Direct connected G. E. direct current, 25 h.p. motor, 240 volts.
Forms.......	Blaw Collapsible Steel Centering Co.	85 ft. of forms equals 28 pieces. Thickness of plate = ⅛ in. Interior bracing of 4 curved 6 in. channels and 3 x 2 in. angles.	

In Plate 36, Fig. 2, is seen a photograph of Shaft 19, taken from the west, which shows the hoist, head-frame and muck bins in place for shaft-sinking. But little will have to be done here when the shaft is completed to prepare for tunnel driving, except to install the cages and tipples.

POWER PLANTS.

In drawing up contracts for the City Tunnel, it was planned to eliminate, as far as possible, any annoyance to the public from noise, smoke and dust arising from the prosecution of the work, particularly at the shafts in the built-up sections of the city, by requiring that, so far as practicable, electric power be used instead of steam. On Contract 63, that of Mason & Hanger Company, comprising Shafts 1 to 5, inclusive, which are located in the undeveloped portions of the city, steam power has been largely used; through arrangements made between the contractor and the Park Commissioner of the Bronx, the contractor agreed to fill for the city a large area of swamp in Van Cortlandt Park, without other consideration than that he be allowed to locate there a central steam compressor plant and to lay pipes through the park in which to distribute the air to the five shafts of his contract. This compressor plant, which has a capacity of 12 500 cu. ft. of free air per minute, has been in operation for several months, and compressed air is used at the shafts of this contract for drills and, to some extent, for pumping. Steam hoists were used temporarily for sinking the shafts, but the permanent hoists are operated by electricity and some pumping is being done by electrically-driven pumps. By the above plan, all smoke and dirt is confined to the central power plant, which is located in a section of the park where no annoyance can arise.

On the next contract, 65, that of the Pittsburg Contracting Company, comprising Shafts 7 to 12, inclusive, no steam plants have been used; even the temporary hoists were driven electrically. Ingersoll-Rand motor-driven compressors, having a capacity of 350 cu. ft. of air per minute, sufficient for the hand-hammer drills used in shaft-sinking, have been placed at five of the shafts; but two of the shafts, 9 and 11, have been sunk entirely by electric drills, and no compressors have been installed.

On Contract 66, that of Grant, Smith & Company and Locher,

compressed air for the operation of the drills is being supplied to the first three shafts, 13, 14, and 15, from a central compressor plant equipped with three électrically-driven two-stage compressors of the Sullivan Machinery Company, having a total capacity of 6 300 cu. ft. of free air per minute. This plant is located in Central Park, within the contractor's enclosure, at Shaft 14, and the air is piped through the transverse roads and along the sidewalk of Eighth Avenue to the other two shafts. At the three southerly shafts of this contract, 16, 17, and 18, and in all six shafts of Contract 67, Shafts 19 to 24, inclusive, which is being carried on by Holbrook, Cabot & Rollins Corporation, each shaft has an independent electrically-driven compressor plant, comprising, on Contract 66, a single Ingersoll-Rand two-stage machine of a capacity of 2 100 cu. ft. of free air per minute, and on Contract 67 two Ingersoll-Rand two-stage compressors, one of a capacity of 1 200 cu. ft. and the other 900 cu. ft. of free air per minute.

Alternating current is supplied to the shafts in the Boroughs of Manhattan and the Bronx by the New York Edison Company and its subsidiaries, and to those in Brooklyn by the Edison Electric Illuminating Company of Brooklyn, at a voltage of about 6 600. This current is stepped down to 2 200 for the hoists and compressors on Contract 65, and to 220 volts for power, lights and blasting on Contracts 63 and 65. The alternating current at 6 600 volts is delivered directly to the compressors on Contracts 66 and 67, and from this reduced to a voltage of 440 and 220 for power, and to about 110 for lighting and blasting. Direct current at about 220 volts is used for the hoists, at 110 volts for lights and small motors on Contracts 66 and 67.

Cages and Hoists.

The shafts thus far completed have been equipped with single-drum Flory and Lidgerwood hoists, which are capable of operating at a speed of 400 ft. per minute two balanced cages, each with a 5 x 8-ft. platform. On two contracts, 65 and 67, platform cages, weighing about 3 000 lb., are to be installed; on the other two, 63 and 66, self-dumping cages, weighing about 4 500 lb., are being put in. The safety devices on all cages are tested as soon as installed, and at frequent intervals thereafter, and the hoists are being equipped with devices to prevent overwinding of cables.

Drills.

On Contracts 63 and 66, and to a large extent on Contract 67, large $3\frac{1}{4}$- and $3\frac{5}{8}$-in. piston drills, mounted on tripods, have been used for sinking the shafts. On Contract 65, however, the Pittsburg Contracting Company has successfully used, on 5 of their 7 shafts, several kinds of hand-hammer or Jap drills, including the Sullivan drill, which weighs about 60 lb., and the larger Ingersoll Rotating drill, which has a weight of about 90 lb. The use of these large hand drills marks a distinct advance in shaft-sinking methods. Among their advantages, it should be noted that the hand drill requires for its operation but one drill-runner, without a helper; the drill is easily handled in the shaft; no time is lost in setting it up or moving it, and it may be operated while mucking is going on. The drill cuts fully as fast as the large tripod drill, with much less air, and little trouble, other than with the drill steel, is experienced in drilling 7-ft. to 8-ft. holes in moderately hard rock. Of course, the hand drill makes a smaller hole than the larger piston drill. The rotating Jap drills are also being used successfully on Contract 67, but in the hard granitic rock of the Brooklyn shafts their use has been confined to trimming holes, the cut and reliever holes being drilled with $3\frac{5}{8}$-in. piston drills, mounted on tripods.

Three types of electric drills have also been used on Contract 65, the Fort Wayne, the Pneumelectric, and the Dulles-Baldwin. The second type of drill is used in sinking Shaft 11, and the last in sinking Shaft 9. Alternating current at 220 volts is delivered to these drills through a cable and manifold suspended from the top of the shaft. The electric drills effect a large saving in power, and no doubt, when perfected, this type of drill will have a large field of usefulness.

ACKNOWLEDGMENTS.

I wish to make acknowledgments to Messrs. Lazarus White and Bertrand H. Wait, Division Engineers, in immediate charge of the City Tunnel, and to Mr. J. S. Langthorn, in charge of the Executive Division of the City Aqueduct Department, and to Mr. M. J. Ungrich, Assistant Engineer, and others, for their assistance in compiling the information contained in this paper.

DISCUSSION.

A MEMBER.—On the first slide shown of the pipe lines running from Brooklyn to Staten Island, there seemed to be an extension on the Jersey coast, one coming out at about Port Monmouth, or somewhere there.

WALTER E. SPEAR, M. M. E. N. Y.—We are not invading New Jersey. The conduit leaving Shaft 23 goes through Third Avenue, Park Place, Fifth and Sixth Avenues, to Bay Ridge, and crosses the Narrows at Seventy-ninth Street, to the foot of Arrietta Street on Staten Island, and from that point passes in the most direct route up to Silver Lake, where the proposed Reservoir is to be constructed. That is the end of that conduit. The other conduit, leaving the tunnel at Shaft 24 at Fort Greene Park, is to be laid through Willoughby Avenue to Queens Borough, and ends at Thompson Avenue. Those are the only conduits we propose to build.

SIDNEY W. HOAG, JR., M. M. E. N. Y.—Mr. Spear, what do you mean by the terms waterway shafts and section valve shafts? What is the distinction between such shafts and others?

MR. SPEAR.—The waterway shafts of the City Tunnel are those through which water will be drawn from the tunnel for the supply of the City.

Only one of the shafts of the City Tunnel—Shaft No. 1—is a construction shaft similar to most of those in the other pressure tunnels of the Catskill Aqueduct which are filled in and plugged when the tunnel is finished. One other shaft—No. 11—is a drainage shaft, without a waterway, so that twenty-two out of the twenty-four shafts are waterway shafts and have one or more riser pipes in them connecting with the distribution mains.

A section valve will be placed across the tunnel at Shafts 13 and 18, which will serve to cut off the portion of the tunnel on either side, for inspection or repairs. These shafts are, therefore, termed section valve shafts.

MR. HOAG.—What is the grade of the flow line across the Narrows from Brooklyn to Staten Island?

MR. SPEAR.—With a flow of 250 million gallons per day in the City Tunnel and a delivery of 10 million gallons per day to Staten Island, the gradient in the 36-in. pipe across the Narrows will be about Elevation 260 above sea level. With the full flow of 500 million gallons per day through the City Tunnel, the gradient in the Narrows will be about Elevation 230.

MR. HOAG.—You propose to lay the 36-in. pipe across the Narrows in a dredged trench?

MR. SPEAR.—Yes, in a dredged channel; and the pipe will probably be laid from a cradle supported on one or more scows, much the

same as a pipe of the same size was laid across the Harlem River some time ago.

The conduit from Shaft 23 is to be a 66-in. steel pipe, and a portion of it is now being laid on Sixth Avenue. From Fifth Avenue and Thirty-sixth Street to Silver Lake, with the exception of that section in the Narrows, 48-in. cast-iron pipe will be laid. The first section of the conduit from Shaft 24 to Queens Borough is also to be a 66-in. steel pipe as far as Willoughby Avenue and Broadway, and a 48-in. cast-iron pipe the remainder of its length. Three out of the four contracts in Brooklyn and Queens Boroughs are now under way.

SAMUEL C. THOMPSON, M. M. E. N. Y.—Is it intended, Mr. Spear, that the entire pressure from the tunnel will enter into the distribution?

MR. SPEAR.—In the low-pressure districts there will be regulating valves in these chambers at the top of the shafts, by which any desired pressure may be maintained on the distribution side. In the high-pressure districts of Manhattan, Brooklyn and Richmond it will not, of course, be necessary to make such reductions in pressure.

MR. HOAG.—Then, Mr. Spear, the idea is, by this system to deliver water direct from the Catskills into the houses, without the intervention of receiving or distributing reservoirs?

MR. SPEAR.—That is true, except for Hill View Reservoir in Yonkers, just beyond the City line, and the terminal reservoir in Staten Island.

MR. HOAG.—Will the Hill View Reservoir be a part of this system? Will the head there control the pressure?

MR. SPEAR.—Yes, the head there will control the pressure in the City Tunnel.

WILLIAM F. LAASE, M. M. E. N. Y.—Mr. Chairman, I would like to ask Mr. Spear what would happen if the valve at the foot of the riser should get out of order? What provision has been made for repairing it, or how long a time it would take if serious accident happened to it?

MR. SPEAR.—None of these valves have yet been purchased or delivered, but I understand that they are of the simplest design and the likelihood of their getting out of order is exceedingly small. Should it be impossible at any time to open or close one of these valves when desired, there would be nothing else to do but to close off the nearest section valve and pump the water out of the tunnel. We believe that this will seldom be necessary, because these riser valves are to be used only in an emergency, and will therefore not be operated frequently. There are two valves on each connection

at the top of the shaft, one of which is to be a service valve and the second which is kept in reserve and on which very little wear, of course, can take place.

MR. HOAG.—Is there anything, Mr. Spear, in connection with this City Tunnel system that prohibits its becoming a part of the present distribution system in Manhattan?

MR. SPEAR.—The gradients in a large part of the present distribution system of Manhattan are too low to permit of the City Tunnel becoming part of this system, in so far as a flow may under present conditions take place in either direction between the tunnel and the distribution system. If it were desired to do so, however, the tunnel could in part be operated at a lower gradient than now proposed by closing off one of the section valves and using a portion, say between Shafts 13 and 18 or that portion between 18 and the Brooklyn shafts, as a part of the distribution system.

LAZARUS WHITE, M. M. E. N. Y.—As I understand the paper, it was primarily a progress report. It was not intended to be a full exposition of why the City Aqueduct tunnel was built; that was pretty thoroughly gone into for a period of three or four years and the project won out handsomely.

When we started work on the Catskill Aqueduct, it appeared that the pressure tunnel would be an exceptional feature of the aqueduct. As the pressure tunnels were built they began to grow more in favor and they won out up the State where deep valleys had to be crossed. It finally dawned on the engineers that it would be a mighty good thing in the city to distribute the Catskill supply by pressure tunnels and to avoid the trouble of constructing surface pipes. The project was such a large one that it naturally met with opposition. We are now far enough advanced to know that the difficulties which the opposition raised were largely imaginary. There has been no special difficulty in sinking the shafts or driving the tunnels in the City; we have found that the deeper we go the better we find the rock, and the rocks which we found treacherous in Manhattan at 60 ft. are much better at 200 ft. Except in a few instances the tunnels are remarkably dry. As for the quality of the rock in the tunnel we know now that these tunnels will not be difficult to construct, and we believe that we have done the hardest work in getting down to rock through the cover of sands and gravels.

It would appear to me that, in the future, deep tunnels will be resorted to for other purposes besides delivering water. Instead of periodically ripping up the streets, it seems that tunnels distributing gas and electricity might be built. Considering the amount

of work we are doing, I think anybody will admit the disturbance at the surface is very small. The shafts are inconspicuous, and, except for a few of our neighbors, only a few are being disturbed.

The average progress of sinking the shafts in the City will probably average higher than on our other tunnels, although the individual records will not be as high. The tunnels will probably be constructed at a rate not as high, relatively, as the shaft sinking, due to the unfavorable conditions of working in the City and the character of the rock structure.

Mr. Hoag.—What is the relative cost per linear foot between shaft and tunnel?

Mr. White.—It is hard to state from the contractors' prices, since the contractors have a tendency to bid a little high on the shafts to pay for the first expenditure on plant and equipment. About two to one is probably the actual relative cost.

Mr. Hoag.—Is not the fact that there has been so little water in the shafts and tunnels somewhat of a revelation? Was that anticipated by the geologist?

Mr. White.—I believe the amount of water has been less than could reasonably be expected. Some of the shafts have been almost bone dry.

Bertrand H. Wait, M. M. E. N. Y.—I have nothing of interest to add to Mr. Spear's paper, unless it might be a few words in regard to some of the details which affected progress on the City shafts up to date.

Previous to starting work on the Catskill system, the shafts which had been sunk in New York State were very limited, both in number and depth. As a general rule, these shafts formed a very small proportion of the work in hand, and the contractors did not organize especially for them. They put an organization on the ground to take care of the major part of the work and let their men sink the shafts as best they could.

When the Catskill work was started, it was realized that the number of shafts to be sunk and their depth made them something of a problem in themselves. Shaft-sinking organizations were brought in from the Pennsylvania and West Virginia coal regions by the different contractors. These men were all experienced when they first came on the Catskill work; they sank shafts on the different contracts all the way from Ashokan to the City and became more expert as they got accustomed to the different rocks encountered in this part of the country. The result was that the City Tunnel reaped the benefit, as we were able to get the best of the gangs which had been working along the line. It was due to these organizations that most of the good progress has been made here.

Another thing which helped out progress on the City Tunnels was the fact that most of the shafts were circular in section. In these circular shafts it is possible to do all the drilling for a round on one shift, mucking the other two shifts, and in this way getting one round out of the shaft each 24 hours. This works out well both for speed and cost. All the drillers can be carried on one shift and each day the drillers and muckers have a definite task before them. The rock also stands up much better in circular shafts than in the rectangular ones, and it is possible to sink safely to greater depths before following up with concrete lining.

A method of sinking followed to a considerable extent on the City Tunnels, which was not tried out in this part of the country previously, was the use of small hammer or jap drills. Several types of jap drills were tried out, but the best progress was made with the Ingersoll rotating drills. These drills weigh about 90 pounds each and can be handled by one man. They require no tripods, and only one helper to every four or five drill runners. In ordinary rock, holes to a depth of 10 ft. can be drilled as fast as with the ordinary slugger drills. On account of having no tripods or heavy drills to get into the hole, the shifts can get in so much quicker than when they have the big drills to handle. When the drilling is finished they can also pick up and get out of the hole in a shorter time.

Conditions were not as favorable for speed in the City as up the State, where the shafts were outside of city limits and where the blasting did not disturb the residents. There were some delays in getting started, due to the fact that it took some time to get the necessary permits to go ahead with the work. All that the contractors up State had to do was to set up a derrick and boiler and start work. The time of shooting in the City has, in general, been kept within the hours of 7 A. M. and 11 P. M., as it was found that blasting during the late evening or early morning hours disturbed the residents in the vicinity of the shafts. Another thing which caused some delay was the problem of getting muck away from the shafts. In only a few cases was it possible to spoil near the shafts; it all had to be hauled a considerable distance by teams or motor trucks.

Taking everything into consideration, the general progress on these shafts to date has been better than could be expected. This has been due primarily to the superior organization of the contractors and the good quality of the rock encountered. The most notable advance in methods that has been developed on the City Tunnel has been the use of jap drills in sinking.

HERBERT M. HALE.*—I would like to say that, of course, in starting work in the City of the magnitude of the City Tunnel, the problem of our relations to the several departments of the City government was an important one. The contractors have, without exception, found that the City departments are well organized, and contractors have been very well treated by everybody concerned. Of course, the Board of Water Supply could not buy all the private property at the site of the City Tunnel shafts which was necessary to carry on this work, but the other departments came to the rescue and allowed us to bridge streets and encroach a little on the highways and parks. With all the restrictions placed by the City on our operations, there was one thing the City department did not do—they did not set any limit as to how high we could go above the ground with our plant. In many cases by building several decks, as at Shaft 19, we have thereby more than doubled the working areas.

MR. SPEAR.—I want to add a little more about this question of permits. The Board of Water Supply have not the broad powers which the old Rapid Transit Commission had—to go anywhere they chose—and we have had to make application to the departments having jurisdiction over City lands for permission to occupy them, and the contractors have had to go to them for many permits for carrying on their work. I want to state that we have been very well treated by the other City departments. Furthermore, I want to say that if there has been any delay in securing permits it has been due to the contractors who came in here without knowledge of the City departments, and who did not at first know just where to go to get the permission they sought.

MR. HOAG.—It does seem that, for work of this magnitude and importance, it is being conducted with far less fuss and feathers, as far as the lay observer can see, than has characterized any great public or municipal improvement heretofore. I mean by the "lay observer," those outside of the Board of Water Supply, and I think it is due largely to the co-operation of the various departments in lending their aid and assistance on lines of least resistance.

WILLIAM F. LAASE, M. M. E. N. Y.—I have been led to believe that a daily supply of about 200 000 000 gal. will be available in Brooklyn by the end of 1915, and I would like to ask if the rate of progress on the work confirms that belief?

MR. SPEAR.—Yes. Contract No. 67, the last contract in lower Manhattan and Brooklyn, is the one which will take longest to complete. That is to be completed in December, 1915, and, at the present time, the contractors are ahead of their schedule.

*Engineer with Holbrook, Cabot and Rollins Corporation, Contract 67 of City Tunnel.

THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.

Paper No. 73.

PRESENTED MAY 22, 1912.

THE STORY OF THE MAINE.

BY WILLIAM M. BLACK.*

From Stenographic Notes of the Lecture.

INTRODUCTION BY SIDNEY W. HOAG, JR., M. M. E. N. Y.,
PRESIDENT OF THE SOCIETY.

SIDNEY W. HOAG, JR., M. M. E. N. Y.—LADIES AND GENTLEMEN—Over fourteen years ago the whole civilized world was shocked at the startling news that one of our new battleships, while lying at anchor in a friendly harbor and on a friendly mission, had met a tragic fate. The circumstances surrounding that instance were of such a character as to concentrate toward Washington the gaze of the entire world, in an almost certain expectancy as to what action traditional American prowess and patriotism would inspire the Government to take. You all know that Congress spoke, and you all know that things began to happen, and ever since the cherished wreck of that battleship reposed quietly and undisturbed in the bottom of Havana Harbor, until recently the Federal Government, acting under the pressure of popular sentiment, decided to remove that wreck and bestow upon it a dignified burial, with all naval honors.

We have with us this evening a gentleman, the senior member of the Board of Engineers of the United States Army, consisting of three members selected by the Chief of Engineers, to direct and take charge of the difficult work of raising that vessel from the slime and mud of Havana Harbor and float it. He will tell you the whole story of the *Maine*, from the time she passed Morro Castle

* Colonel, Corps of Engineers, U. S. Army

until after she was floated through the efforts of this expert engineer commission and towed outside of the three-mile limit. The sea cocks were opened and she settled quietly and proudly and disappeared for all time to a sailor's grave, at the bottom of the ocean.

I take particular pleasure, personally, in having the honor of presenting to you Col. William M. Black of the United States Army, Corps of Engineers.

Col. William M. Black.—In giving you the story of the *Maine* this evening, I will tell you a little of history and how the work of raising was done, and will endeavor not to be too technical and yet to give an idea of the reason for the *Maine* being in Havana Harbor, the source and nature of the explosion which caused her destruction and of the removal of the wreck and final burial.

You all probably remember the events in Cuba prior to 1897. The Cubans were making a struggle for liberty against the Spanish throne. The war had gone on for a number of years; Spain had a large and well-organized army in Cuba, and toward the end of 1897 the Cubans were practically at the end of their resources. Through the whole of this struggle the Government of the United States endeavored to maintain neutrality. The efforts to this end, however, were, to some extent, neutralized by the acts of our individual citizens. It is a fact of common knowledge that filibusters were fitted out and succeeded in carrying arms and ammunition to Cuba, in spite of the efforts of the Government. The result of this attitude on the part of our people, who acted in accordance with their sympathies toward the Cubans, was that all Spain and the Spanish population of Cuba became highly incensed against the Americans. Conditions became extremely acute in Cuba and it was feared that the lives of the Americans there were in danger. We were on the lookout for something to happen. There was a large party in the United States that was demanding intervention. Mr. McKinley, our President, was doing his best to maintain peace.

In this nervous state of affairs it is said that a rather curious thing happened, which, if the tale is true, shows how on little things great events may be hinged. There was an American war correspondent—at least that is the tale—I think then on the staff of the *Herald,* in Havana, and he had been there for some time telegraphing to his paper the various events as they occurred.

The telegrams were censored, so that he had arranged a code, one word meaning one thing and one word another. On one occasion he lost his revolver, and having to go into the field frequently he was unwilling to be without so useful an implement. So, knowing that he could not buy one in Cuba, he arranged with the purser of one of the passenger steamers entering Havana to bring him a revolver. It was duly delivered, but the cartridges he had for the old one would not fit and so it became necessary for him to get a supply. Thereupon he sent a telegram to the United States somewhat in these words: "Camera received. Sent no films." This went to Key West and was repeated to New York. The cable operator at Key West thought it was an important cipher and he proceeded to translate it by a code of his own. At any rate, the rumor was started in Key West that it had been cabled from Havana that the life of General Lee had been threatened and that a warship should be sent to Cuba. This rumor went in due time to Washington, and although it was not confirmed by General Lee, for some reason a warship, the *Maine*, was ordered to Havana. The *Maine* was then one of our best vessels. She was the first of our modern battleships and she had been kept in readiness in case trouble should arise.

The Spanish authorities were desirous that no warship should go to Cuba, fearing that something might happen which would rupture the good relations between the United States and Spain. A high Spanish officer went to General Lee shortly before this event and asked him that a warship be not sent, guaranteeing that the lives and the property of the Americans should be safe, and General Lee promised, in turn, that no warship should come. And what is more, it is stated he said, "They will not send one unless I ask for it"; so that, when the *Maine* appeared in the mouth of Havana Harbor, it was entirely unforeseen by General Lee. He was surprised, as well as was the Spanish government.

For this sending of the *Maine* some reason had to be given. For diplomatic reasons it could not be said that it was sent in the thought that General Lee's life was in danger, so the statement was made that the warship went over on a visit of courtesy; that there had been some slight unpleasantness between the Spaniards and the Americans which had prevented such friendly visits for some time, but that that had passed and the visit of courtesy should be made. At least so runs the tale.

The commanding officer of the *Maine,* Admiral Sigsbee, then Captain, was one of our best known officers. His executive was also one of our best known and best officers, Admiral, then Lieutenant-Commander, Wainwright, and these men, knowing the condition of affairs in Cuba, took no chances. So before entering the harbor on January 24, 1898, they sailed along the north coast a little way to the eastward and then to the westward, then came back and entered the harbor with their ship in condition for whatever might be met. Everything was quiet, everything went well and the ship was taken, as is customary there, to one of the buoys. At that time there were no wharves in Havana long enough for large vessels and such vessels were taken by the pilots on entrance to mooring buoys at certain points of the harbor and made fast. The *Maine* was taken to a buoy about midway in the harbor, about 1 500 ft. from the Machina wharf—that was the wharf where the landings for the customhouse were made—and the buoy lay directly in the line of the ferry between Havana and Regla, a line that was traversed constantly, not only by the steam ferry-boats, but by multitudes of small boats. These boats were ship's boats of quite considerable tonnage. Over the stern they had an awning. These were going to and fro all the time, so that during the entire time the *Maine* lay in Havana Harbor it was quite impossible to prevent boats from passing to and fro over the anchorage ground. The utmost vigilance was observed on board the *Maine* to prevent any hostile or threatening action.

The usual visits of courtesy were given and returned. Such visits were made to the Spanish officials and also to the Cubans, and everything seemed to be very quiet.

Now, if you will turn out the lights, we will have the first picture:

Plate I (Plate 43, Fig. 1) shows the *Maine* entering Havana Harbor, with the Morro Castle in the background. The *Maine* was 324 ft. long, with 57 ft. breadth of beam. Her draft was 21½ ft., and her displacement 6 650 tons. She carried four 10-in. guns, in two turrets, one on the starboard side forward and one on the port side aft. She also had six 6-in. guns and a minor battery, and was provided with four torpedo tubes.

Now, in order that you may better understand her structure, I want you to examine Plate 2 (Plate 44). This is a longitudinal

section of the *Maine,* and a plan showing the subdivision of her hold. Please notice the positions of the boiler-rooms and of the magazines. The ribs which show between the inner and outer bottoms are known as transverse floor plates or frames. The bulkhead between the two boiler-rooms is at frame 41. Frame 18 is just forward of the foremast. Note also the transverse bulkheads, and the position of the protective deck, shown by the heavy line.

In those days, you will remember, they used the brown prismatic powder for all the heavy guns. It is a chemical mixture not subject to self-ignition.

I have shown you the arrangement of the magazines forward and aft, and I have shown you the position of the coal bunkers. In the ordinary routine of a ship, all of these parts are watched with the utmost care, and on a well-regulated ship there is almost no chance of any accident occurring. There were no electric wires in or around the coal bunkers or magazines.

The forward coal bunkers were partly empty; the forward boilers were cold; a little steam was kept in the after boilers for the purpose of running the ventilators and electric lights. All of the regulations had been strictly observed on board of the *Maine,* and everything seems to have been in most excellent order. Personally, I made an examination of the after magazines, as soon as the water was out, and found everything there, after fourteen years of submergence, in perfect order. From that, the condition of the forward magazines at the time of the explosion could be judged.

On the evening of the 15th of February, 1898, there had been a small company of people out to dinner on the *Maine,* and these had gone home. Many of the men had retired. Almost all of the officers were aboard; I think only two were ashore. Almost all of the enlisted men were aboard. Their quarters were from amidships forward. The Captain's and the Admiral's cabins were in the after main deck superstructure. Directly below them was the ward room, the quarters of the officers.

About 9:40 P. M. there was a series of shocks. The first one is described to have been a rather slight shock, and that was followed by a tremendous shock and a series of explosions. The ship sank almost immediately—so rapidly that the officers on the berth deck immediately below the main deck were not all of them able to reach

the deck. Two of them were caught and drowned. As soon as the Captain reached the deck he found the ship was doomed and was sinking very rapidly. He summoned the officers and the few enlisted men present aft, and they went to the relief of their comrades whom they heard calling from the water. At the same time the boats of the Spanish war vessels around also were lowered, as were the boats of several American merchant ships.

The full extent of the damage could not be realized until the following morning, when it was found that apparently the whole forward half of the *Maine* had been destroyed. Two officers and 264 of the crew were missing. Of them, 188 bodies were recovered, leaving 78 men unaccounted for.

Everything was done by the Spanish officials for the care of the wounded which could be done. It is said that when our Consul-General went to the palace, as soon as the disaster was known, he found the Spanish Governor-General in tears, deploring the event, saying, "Oh! My country, my country," knowing what the result would be. There were Spaniards in Havana, doubtless, who rejoiced. With the Cubans, there was a mixture of feeling. The Cubans were most anxious to bring about intervention by the United States, and while they deplored very greatly the death of so many Americans, yet, in a measure, they rejoiced at the loss of the ship. They knew the final effect of the explosion would be a war of intervention, and they knew, too, that without such intervention their cause was doomed.

Immediately a Board of Inquiry of Naval Officers was summoned, and went to Havana. Divers were sent down; all the armament that could be recovered was removed, including the torpedo war-heads and two six-in. guns. The gun cotton used in the torpedoes was the only high explosive in the ship, and this was taken out. A careful examination was made of the nature of the wreck. As a result of the evidence taken, the Board of Inquiry reported to the President of the United States that the *Maine* was sunk by a series of explosions, the first of which was exterior to the ship. Then followed the war and the other events of which we know.

The Spanish authorities also had a Board of Inquiry, which found that the *Maine* was blown up by an internal explosion. During all the years which followed, criticisms were freely made of

the United States for neglect, not only of its warship, not only of leaving an obstruction of this character in the harbor of Havana, but also of the neglect to care for the remains of the men who had gone down with the ship; and some critics said that the reason we did not remove the wreck was that we were afraid to have it known to the world what was the cause of the destruction of the *Maine*, alleging that the *Maine* was sunk, through carelessness, by an internal explosion.

So matters went on until 1910, when public agitation led to Congressional action for the removal of the wreck, and laws were enacted directing the Secretary of War and the Chief of Engineers to take such steps as might be necessary for the speedy removal of the wreck of the *Maine* from Havana Harbor.

Plate 3 (Plate 43, Fig. 2) shows the appearance of the wreck as it lay in Havana Harbor through all these years.

The Chief of Engineers promptly convened a Board of three Engineer officers of the Army to take charge of the work of removing the wreck from the harbor.

From the tenor of the debates it became evident that there were several results desired by Congress in ordering the work. The remains of the dead were to be recovered and taken to Arlington National Cemetery for burial; the ship's main mast was to be removed to Arlington and there placed as a monument by the graves of those who had perished; if possible, the cause of the explosion should be made clear; and the wreck should be removed from the Harbor of Havana.

There are many different ways of removing a wreck from a harbor, and immediately after the passage of the law a multitude of people thought it devolved upon them to tell how to do it. The Secretary of War was simply inundated with letters and plans and these were all sent to the Board for consideration and report. They all had to be answered. Some of them were really quite curious. Many of them were from capable engineers and were good, but the greater majority of them were not exactly such as you would call practicable. One lady wrote that she was very much occupied and really had not been able to give as much time as she should to this problem, but felt it necessary to describe the method to be followed. Another person said it was a simple matter to take up

FIG. 1.—"MAINE" ENTERING HAVANA HARBOR, JANUARY 24TH. 1898.

FIG. 2.—APPEARANCE OF WRECK, SEPTEMBER, 1910.

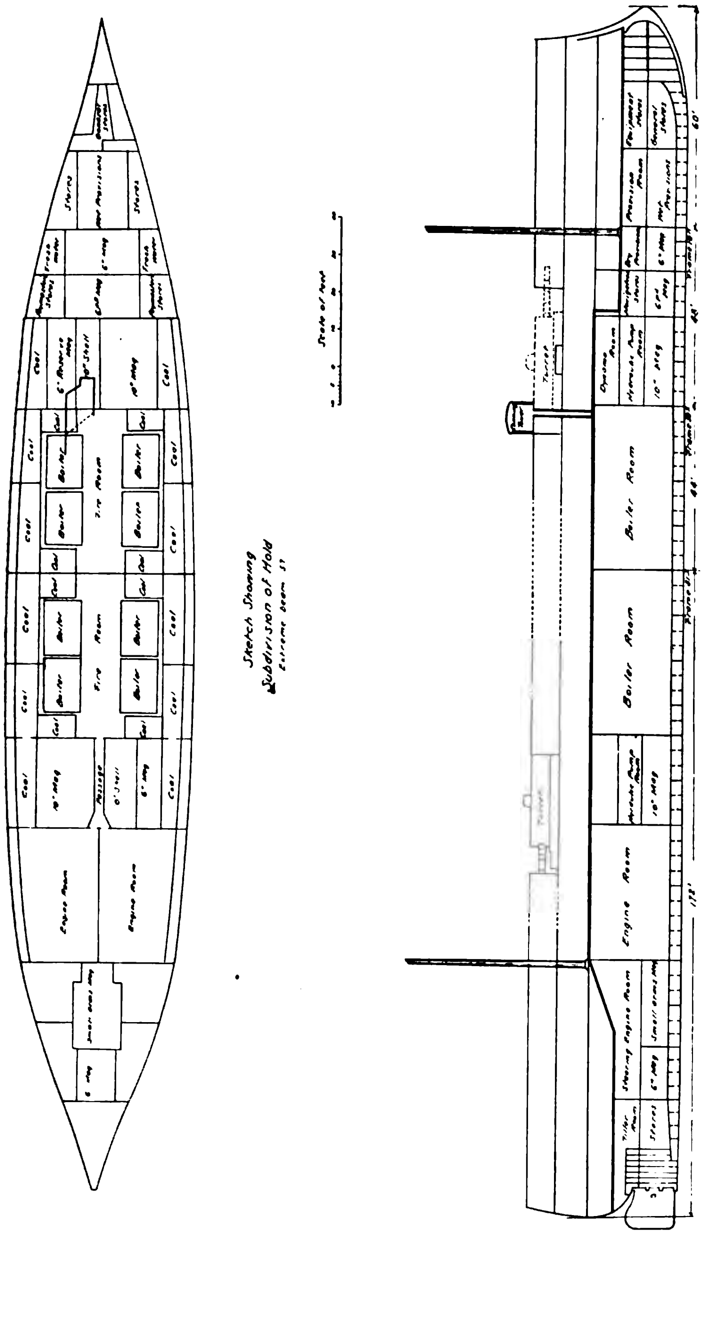


PLATE 44.—SECTIONS SHOWING CONSTRUCTION OF SHIP.

the wreck—just make a lot of magnified ice-tongs and hook them over the ship and lift it out. He did not say to what to attach them overhead. Another man said he had been studying ten years on the question and that he had a plan whereby a little child six years old by pressing a button could bring the wreck to the surface. Another man said, get a lot of hydraulic jacks, insert coils of wire, and put these jacks under the ship, send an electric current through the coils, the water in the jacks would be heated, would expand and lift the wreck. Another gentleman wrote that he had some experience in getting up wrecks which he thought was valuable. He said he lost a motor-boat and had a deal of trouble getting it out. He had found by experiment that an empty sealed tin can would float, and all we had to do was to get a lot of tin cans and fill the wreck with them. Then he added that this would require a good many cans, and he was interested in a factory where they could be made.

Now, one of the conditions which Congress prescribed for this work of raising the *Maine* was that the cause of the explosions should be made known, if possible. You can see from that picture (Plate 43, Fig. 2) that the forward portion of the ship was badly wrecked, just how badly no one could tell. It was evident that if the cause of the explosion could be shown at all, it must be determined from the nature of the wound in the vessel and the way in which the parts of the vessel had been thrown. In order that the wreck could tell its story without any doubt at all, it was necessary that the ship should be exposed without any of its parts being moved. So that all of the methods which called for passing chains beneath the wreck and lifting it to the surface had to be rejected, even if practicable, because it was evident that the strain produced by this method would have dislodged some of the parts, so that no one could tell with certainty how the explosion was caused; or, at least, such a method would give color to statements that findings of cause determined later were unreliable. So that it was evident that there was only one way of doing the work which would fulfill the wishes of Congress, and that was to build a cofferdam around the ship, pump it out and expose the ship without touching any of the parts. That method was adopted.

The wreck lay in water 30 to 35 ft. deep. The harbor bottom at that point was of a soft clay mixed with coral sand. This soft

clay and sand extended to a depth of 55 to 60 ft. from the water surface. Below that was found stiff clay to a depth of 98 to 115 ft., where rock was found. So that the problem presented was to make a cofferdam large enough to contain the entire ship and those portions thrown out from the sides (the ship being 324 ft. long and 57 ft. beam), and strong enough to stand water pressure to a depth of 35 ft. and water and mud pressure to the depth of the keel of the ship, which was about 48 ft. below the surface. These pressures are very great and the dam had to be large in interior dimensions.

Naturally, the use of interlocking steel sheet piling suggested itself, but the question arose how to arrange that steel sheet piling as a wall in such a way that it could exert its maximum strength to resist the strain of an impermeable fill and then to so dispose the piling and fill as best to resist the stress of the enormous exterior pressure of water and mud; water to a depth of 35 ft. and mud to a depth of 48 ft.

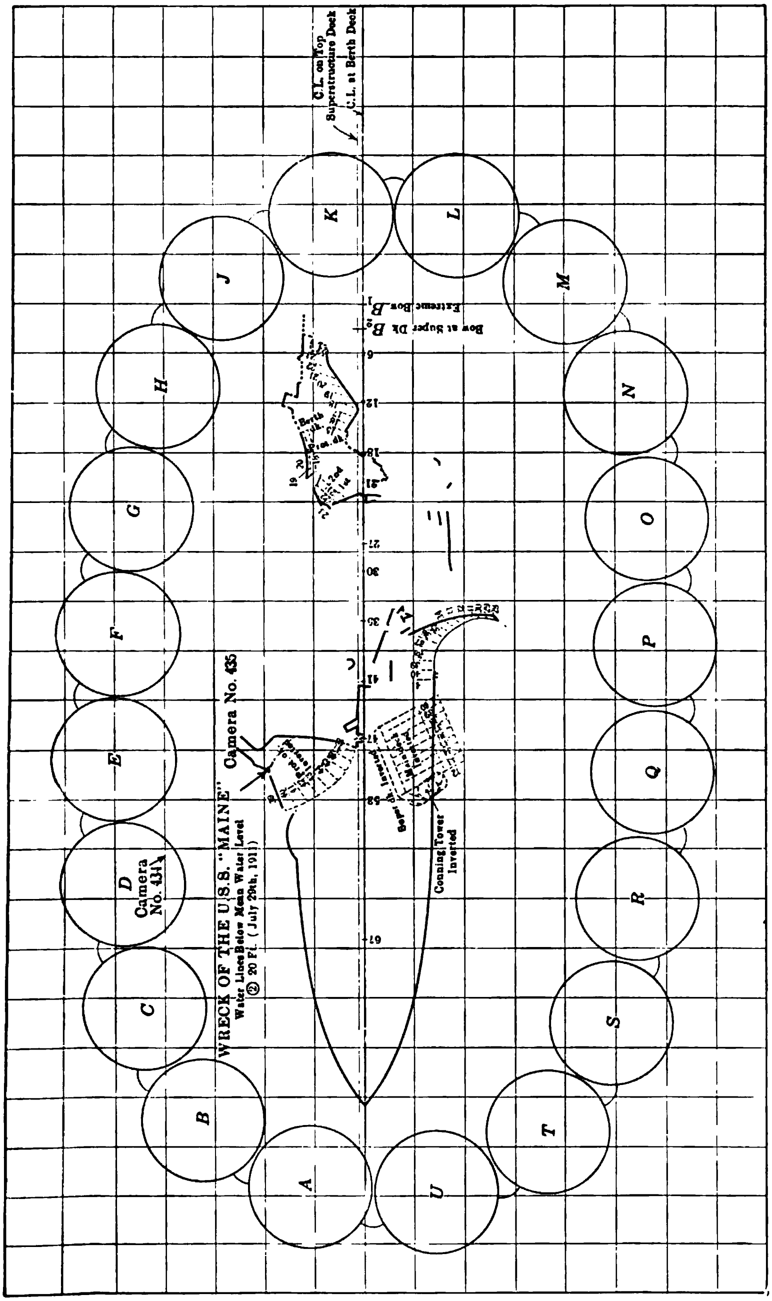
On investigation it was found that in order to develop the strength of the steel sheet piling best, the dam should be made of a series of independent parts, each part being a cylinder, because in a cylinder the interior pressure from the fill acting equally in all horizontal directions will produce an equal tensile strain for any depth on the whole of the envelope and cause no tendency to distortion. This plan was accordingly adopted. On investigation it was determined that the cylinders, in order to be able to stand the exterior pressure to which they would be subjected, would have to be 50 ft. in diameter, and to get a cofferdam of the proper size 20 cylinders would be required. Lackawanna steel sheet piling was selected as being the best adapted for our purpose. These, you know, are plank-shaped pieces of steel with a pair of curved fingers along each side, so that when one pair of fingers is inserted into those of another plank they interlock in the piling used with a strength to resist pulling apart of about 9 000 lb. to the linear inch. The cylinders were connected by arcs of the same materials. These arcs contained about 10 piles. The cylinders each contained about 150 of the size of piling we used, and the arc was connected to the cylinders by what is known as a 3-way piece, formed by attaching by angle irons one-half of a pile along and at right angles to the mid line of the web of a pile. So that you can see we had then a

series of independent dams connected by a flexible arc of piling. Plate 4 (Plate 45) shows the plan of the dam as built. The cylinders and intervals behind the arcs were to be filled with stiff clay from the harbor bottom.

The harbor bottom at the site of the wreck was not uniform in its composition. At some points the stiff clay was found at greater depths than at others. It was deemed necessary that the bases of the cylinders should be firmly inbedded in the stiff clay, and that a penetration of at least 10 ft. into this clay was necessary. The range of tide was but little over a foot, and it was decided to have the tops of the piles at a line of two feet above the low-water plane, building up the cylinders later, if necessary, with plank (as was done subsequently). The length of the piles was accordingly fixed at 75 ft.

A pile of that length weighed a ton and a half. All had to be brought from Buffalo, N. Y. A 75-ft. plank would be a very difficult thing to handle into a ship and out of a ship, and for that reason, and inasmuch as for interlocking the fingers of each pile have to be inserted from the top into those of the next adjacent, it was decided to cut the piles in two parts and joint the parts by fishplates. The piles were accordingly supplied in lengths of 25, 50, 40 and 35 ft., bored for assembling into 75-ft. lengths when driven, the fishplates and bolts being so proportioned as to make the tensile strength at the joint equal to that of the remainder of the piles.

To place the cofferdam, in the center of each cylinder site an ordinary round pile was driven. Around this was built a circular wooden templet 50 ft. in diameter. This floated on the water and was held in place by the round pile. The steel piles were driven around and in contact with the templet. A 50-ft. length was first set. This sank into the mud until the top was three or four feet above the water surface. A 40-ft. length was next inserted and supported on the 50-ft. pile, and so on, alternating the short and the long; then the tops were bolted on and the piles were driven. This was done easily and successfully, the only difficulty was to get the closing piles of each cylinder driven. It is evident that unless the last two piles were parallel to each other, they would not interlock and drive.


WRECK OF THE U.S.S. "MAINE"
Water Lines Below Mean Water Level
② 20 Ft. (July 29th, 1911)
Camera No. 435
Camera No. 434
C.L. on Top Superstructure Deck
C.L. at Berth Deck
Extreme Bow B_1
Bow at Super Dk B_{10}
Conning Tower Inverted
A
B
C
D
E
F
G
H
J
K
L
M
N
O
P
Q
R
S
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U

PLATE 45.

This difficulty was overcome as follows: There is a certain amount of play in each interlock. In each cylinder the piles were placed and driven as described until all of the periphery was completed excepting a space equal to that which would be required for from ten to fifteen piles. These were then placed and driven together, the interlock play in the group being sufficient to allow for the lack of parallelism of the limiting piles in place. The piles were driven with a steam hammer weighing 3 700 lb. The bottom section of each took 6 minutes to place and the top section about 5 minutes. The driving required about 4 minutes per pile.

Plate 5 (Plate 46, Fig. 1) shows one of these cylinders under construction. The Board was convened in August and it began work in Havana in the early part of September. The plans for the cofferdam were finished early in October and the contract made for the sheet piling during that month, on the 27th of October. The first pile was set on December 6th, 1910, and it took from that time until March 31st of 1911 to drive all of the piles.

Plate 6 (Plate 46, Fig. 2) shows a cylinder and connecting arc completed.

It was designed to fill the cylinders with clay from the harbor bottom. The clay proved too stiff to be dredged economically with the dipper or clamshell dredges available. Recourse had to be had to hydraulic dredging, although it was known that in this process the clay would necessarily become finely divided and water soaked, and, therefore, would increase greatly the stresses in the cylinders, and would not for a longer time attain the stiffness desired to aid in resisting the outside pressure. Fifty-seven thousand cubic yards of clay were used in the fill.

The filling was begun in May and completed in June.

In putting the cylinders down, at the site of the cylinder marked "N" obstructions were found which had to be dredged out. One proved to be the starboard bower anchor of the ship. Another was a great disk of steel about 1½ in, thick and about 30 ft. in diameter, which had fallen edgewise and pierced to a depth of 50 ft. It proved to be the top of the forward turret. Lying close by that was the little hood or conning tower of the forward turret. The foremast was found on the port side of the bow on the site of cylinder "K". This mast had been blown out and turned completely over so that it lay with its top pointing toward the ship.

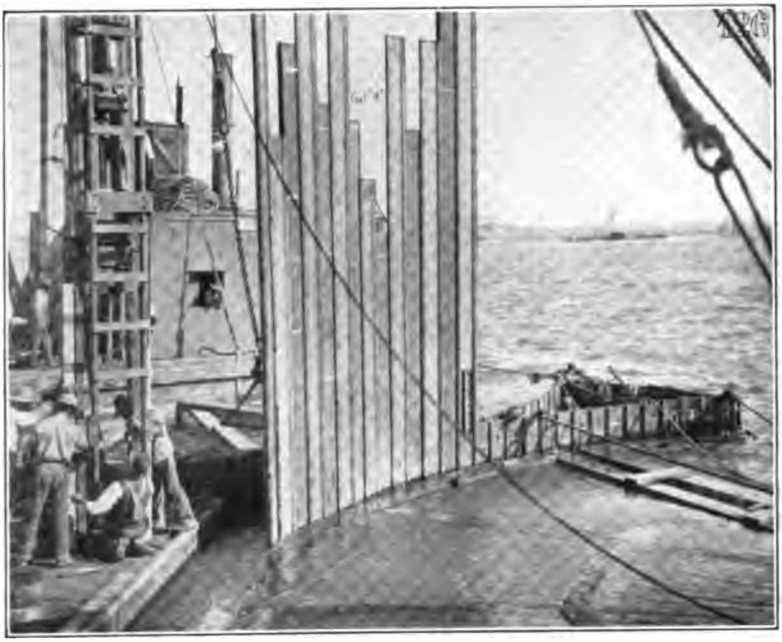

FIG. 1.—CYLINDER "A" UNDER CONSTRUCTION, JANUARY 10TH, 1911.

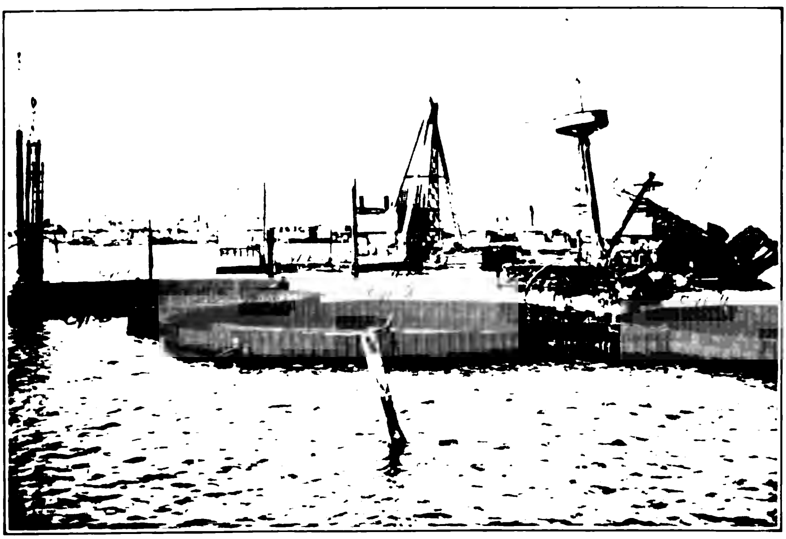

FIG. 2.—COMPLETED CYLINDER AND CONNECTING ARC.

Several setbacks occurred. Cylinder "B" burst just as its fill was completed. The side opened and a portion of the fill ran out. A careful examination was made. This cylinder had been one of the earlier cylinders built, and we had not allowed enough piles to permit sufficient play for the closure. The closure was made with five piles. These had to be driven so hard that the fingers of a pile straightened out and so when the pressure came the cylinder opened. By withdrawing a few of the piles and driving new ones a new closure was made and the cylinder was refilled. Cylinder "N" split in the same way, and when that was examined it was found that a pile was ruptured straight through the middle of the web. Since the web was stronger than the interlock, there must have been some flaw in the pile itself.

We have endeavored to get all the lessons we could—engineering lessons—from the work done at the wreck, and I think the one thing that has been most thoroughly established there is the well-known engineering principle of the total depravity of inanimate objects.

Here we had these cylinders bursting just when filled. As no more breaks occurred we thought all the rest of the piling was in excellent condition and we treated the dam pretty badly later. We piled all kinds of weight on it, subjecting the cylinders to weights beyond the pressure of the fill, and everything held perfectly. When we removed the cylinders finally, we found in one a pile split up to within about 15 in. of the top.

The cofferdam was completed on June 5th, and Plate 7 (Plate 47, Fig. 1) shows it with the water just beginning to be pumped out. One 12-in. pump and one 8-in. pump were used. Really the 12-in. pump was used but little. It was desired to remove the water gradually and allow the filling of the cylinders to dry out in a measure.

In order to assist the cylinders to bear the pressure of the water and mud developed in unwatering the dam, there was placed inside the dam, outside the cylinders, stone of the soft limestone rock found in Havana, and we also piled a certain amount of this rock on the cylinder tops, using in all about 14 000 tons.

The cofferdam was then pumped out gradually and on August 2nd we had the water down until the mud inside was visible, for mud had been deposited within the dam to a height of about 23 ft. in

the process of filling by the hydraulic method. Plate 8 (Plate 47, Fig. 2) shows the appearance of the wreck as then disclosed.

Plate 9 (Plate 48) is a plan of the cofferdam showing the distortion that took place during the entire time the work was under way. The effects of the exterior pressure on the cofferdam were shown by a movement inward on the top of the cylinders. The maximum shortening of the width of the dam was about 19 ft., that is, each of the tops of two cylinders moved toward each other about 19 ft., nearly 10 ft. for each cylinder. The maximum distortion of cylinder diameters was about 38 in. And the plate shows the general appearance of the cylinders at the time when the dam was finally flooded.

This cylinder movement was observed promptly. It was important that we should know, at all times, just what was taking place. To that end, a series of measurements was started as soon as we began to unwater the dam. The cylinder diameters were measured daily, as well as the distances across the dam between the pairs of opposite cylinders. To watch for sudden changes, wires were stretched across the dam, supported on pulleys. These had a weight at each end, with a telltale moving up and down a vertical board attached to the cylinder. The flexibility of the cylinders was really rather alarming. No dam of this type had been tried before; we had no precedents to go by, and when these cylinders took to moving toward each other it was not pleasant. We did not know whether that movement would cease or continue. As far as we could judge, there was no pulling out of the cylinders. We found, when the cylinders were removed, that not a single one of the outside piles had been drawn vertically. If any movement did take place, it was in forcing further into the clay the interior piles of the cylinders. The greater part of the movement was simply a bending of the entire cylinders inwardly.

Now, as I say, we did not know, nor was there any way of determining, what would be the possible extent of that movement. We could not afford to take any chances, so that it was finally determined, after watching the dam for some time, that we would try to limit the movement by bracing, and I will show you how we put these braces in.

FIG. 1.—COFFERDAM COMPLETED AND UNWATERED TO A DEPTH OF FIVE FEET.

FIG. 2.—INTERIOR OF COFFERDAM, AUGUST 2D, 1911. TAKEN FROM CYLINDER "M," LOOKING TOWARD "D" WATER LEVEL — 23 FT.

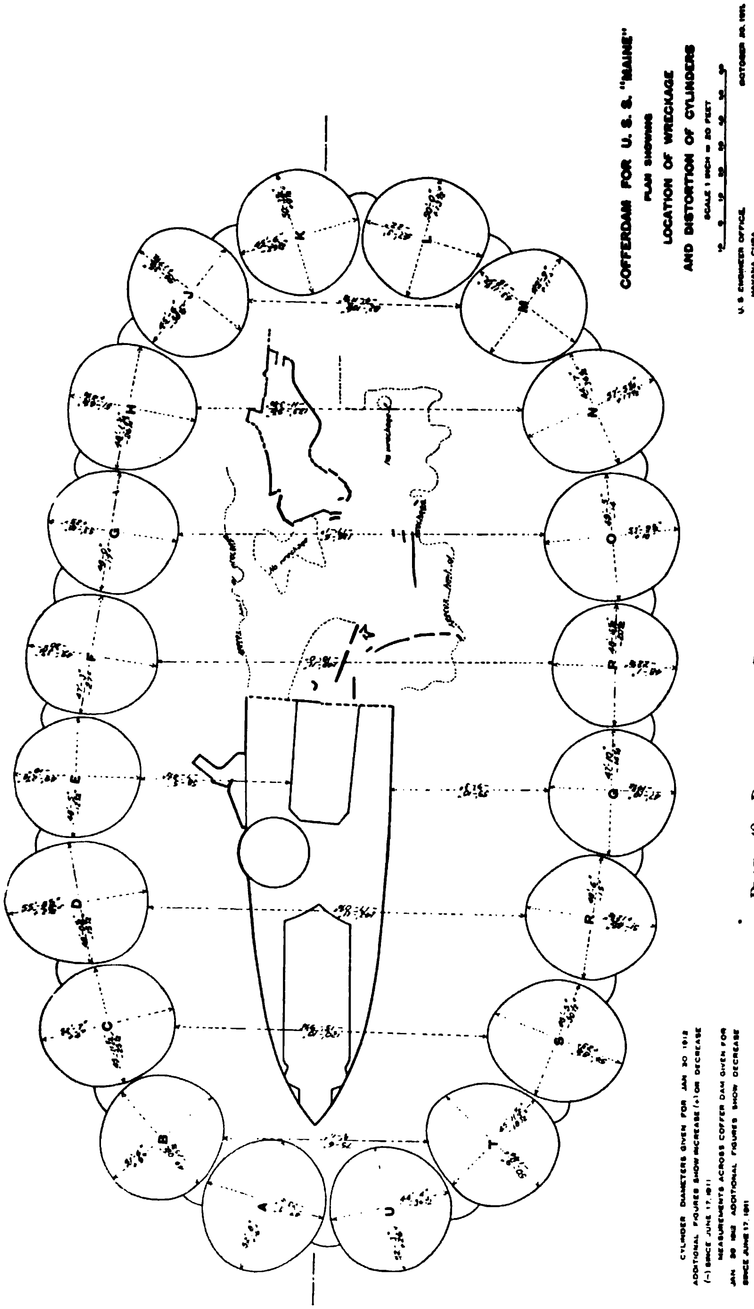

PLATE 48.—DISTORTION OF CYLINDERS, JANUARY 30, 1912.

Plate 10 (Plate 49, Fig. 1), for example, shows the brace between cylinders "O" and "G". Cylinder "G" was known to be in very unstable bottom. The soft mud extended to a greater depth there than at any other point. It had been observed that the cylinder movement would cease entirely at low water, and then as the tide rose a slight inward movement would take place. The extra pressure caused by the rising tide was computed to be about 300 tons per cylinder, so this brace was designed to stand about 350 tons pressure, and it did so. At the brace ends, a concrete abutment was put against each cylinder. A tendency in the brace to buckle was found, and the additional side braces were placed. It is interesting to note that when the brace buckled under this tremendous pressure, we were able to cut it off and readjust it. The maximum pressure found on that brace was 312 tons, as determined by hydraulic jacks, which I will show you later. When this pressure was attained, the brace was cut and shortened. The pressure would gradually increase again. Finally, toward the end of the work, the movement seemed to stop and the cylinders seemed to have reached the limit of flexure.

Opposite the after end of the wreck, the braces were abutted against the side of the ship and carried across by interior bracing.

These braces were a precautionary measure, one any engineer would have taken, and yet the efficiency of them is doubtful.

Plate 11 (Plate 49, Fig. 2) shows the end of the brace at cylinder "O" with the concrete abutment and the recording jacks.

Plate 12 (Plate 50, Fig. 1) shows the end of the same brace at cylinder "G." The distortion of the cylinder under the pressure is evident.

Plate 13 (Plate 50, Fig. 2) shows a brace from cylinder "Q" to the starboard side of the wreck.

Plate 14 (Plate 51, Fig. 1) shows the end of this brace at cylinder "Q" and how the heavy timber abutment was crushed by the pressure.

Plate 15 (Plate 51, Fig. 2) shows the general appearance of the cylinders when the dam was finally flooded. You can see the distortion is not very great. I think the distortion of the Black Rock Dam was considerably greater than the general distortion here.

FIG. 1.—BRACE BETWEEN CYLINDERS "G" AND "O."

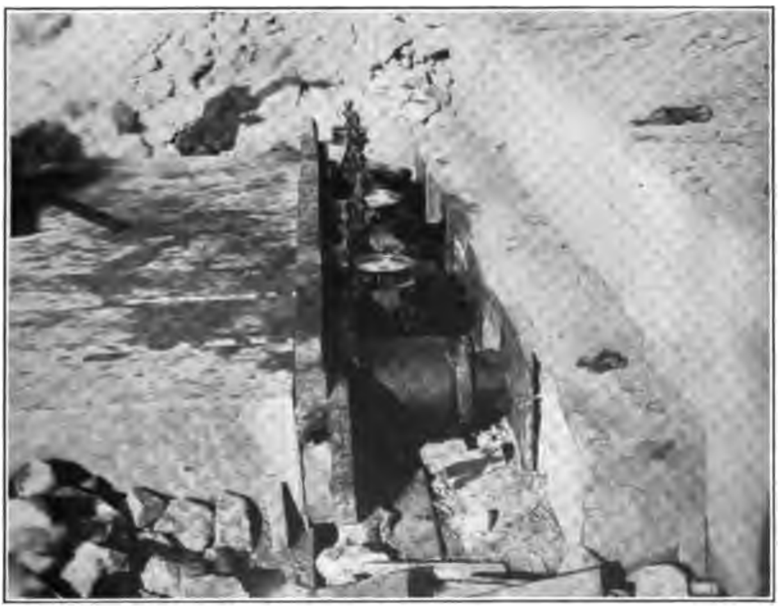

FIG. 2.—BRACE ABUTMENT AND RECORDING JACKS, CYLINDER "O."

FIG. 1.—END OF BRACE AT CYLINDER "G."

FIG. 2.—BRACE FROM CYLINDER "Q" TO STARBOARD SIDE OF WRECK.

FIG. 1.—BRACE END AT CYLINDER "Q."

FIG. 2.—APPEARANCE OF CYLINDERS ON PORT SIDE OF "MAINE," FEBRUARY 10, 1912.

Now we go back to Plate 8 (Plate 47, Fig. 2), showing the condition of the wreck. We are now able to determine somewhat the extent of the destruction of the ship. The mass of wreckage in the right foreground of Plate 8 is that of the bow, from the stem back to frame 18 (near the foremast). In the middle, under the boat crane, is the open end of the after part of the wreck, where cut off by the explosion, at frame 41. Lying on and over the part of the ship aft of frame 41 is a part of the main deck, thrown from forward of frame 41, bottom side up, and having with it the conning tower, the base of which, formerly extending from the main deck to the protective deck, is seen as a black cylinder sticking out to starboard.

The wreckage off the starboard side forward of frame 41 is the wreckage of the protective deck of 1½-in. steel, torn out from in front of frame 41. Instead of being turned over, it is twisted outboard. Forward of frame 41 is a space in which there was no wreckage of any kind visible.

Returning again to the wreckage shown on the right of Plate 8 (Plate 47, Fig. 2), this, as stated above, proved to be the remains of the bow section. A clearer view of it is had in Plate 16 (Plate 52, Fig. 1). To the right of the picture are seen the ruins of the forward part of the berth deck. At the center is the hull of this section, below the protective deck, lying on its starboard side and with the line of the keel, shown by the line through the bases of the two stanchions remaining in place, making an angle with the horizontal of about 35°. This section, about 60 ft. in length from the bow to frame 18, has been almost severed from the remainder of the ship and turned to port through an angle of 110°. The transverse bulkheads have been blown out towards the bow, and the protective deck, for somewhat more than half its width along the port side, blown out, together with all of the upper works. The highest point of the keel, shown by the white cross on the plate, is 31 ft. above the prolongation of the keel of the after intact portion of the ship as she lay. This section is connected with the remainder of the wreck only by the flat outer keel plate, which, from frame 18 toward the stern, is inclined vertically downward for about 15 ft., then sloping with an angle to the horizontal of about 15° to about frame 35, where the keel becomes intact to the stern.

Between frame 18 and frame 41 (see Plate 44), only a little more than half the ship's bottom along the starboard side was left in place. All the remainder was blown out, to the sides and forward and back.

Aft of frame 41, excepting for minor injuries in the vicinity of frame 41, described later, and the partial crushing in of the forward superstructure and the main deck, by the fall of wreckage on it, the hull was intact. The wreckage lying there is that which appears above the water in Plate 3 (Plate 43, Fig. 2). Plate 17 (Plate 52, Fig. 2) shows it after a portion of the ruins of the main deck had been cut away, exposing the inverted conning tower, thrown 85 ft. aft from its place in the ship.

After looking at this wreckage it was evident that it would be quite impossible to lift or to float any of the forward portion of the ship. The only thing that could be done was to take it out piecemeal and bury it at sea. For cutting the steel the oxy-acetylene flame was used. This process is interesting to watch. The flame goes through steel as a knife cuts cheese, but surface rust must first be removed in the line of the cut. It cut through steel even when against wet mud and under a head of water over the mud of from 2 to 5 ft. From the base of the conning tower extended a cylindrical steel tube used for conveying the signal wires. That tube was a steel cylinder about 33 in. in diameter, with walls about 5 in. thick. This was cut through by the flame in 58 minutes.

Plate 18 (Plate 53, Fig. 1) shows the wreck as it first was exposed. The poop deck (wooden) was in fair condition, though eaten away by the teredo at places. The sides of the after superstructure, containing the quarters of the Admiral and Captain, were covered with oysters and barnacles. The main deck had in it a deposit of mud apparently containing bundles of twigs. These twigs, however, were of coral formation and about 12 to 15 in. long.

Plate 19 (Plate 53, Fig. 2) shows the same part of the wreck after the mud had been cleared away. Some of the effects of the long exposure to the action of the sea water were very curious. For example, in the angle between the deck-house and the deck I saw something that looked like a 6-in. pipe extending through the deck. I had the men pry it loose and it turned out to be half of a 6-in. shell that had been split longitudinally, which, when it fell,

FIG. 1.—WRECKAGE OF BOW SECTION.

FIG. 2.—WRECKAGE AMIDSHIPS.

FIG. 1.—STARBOARD SIDE OF AFTER PART OF WRECK JUNE 16, 1911, SHOWING INVERTED CONNING TOWER. WATER LEVEL—10.

FIG. 2.—STARBOARD SIDE OF AFTER PART OF WRECK, JUNE 21, 1911.

FIG. 1.—STARBOARD SIDE OF WRECK AUGUST 2, 1911.

FIG. 2.—PORT SIDE OF WRECK AUGUST 2, 1911.

fitted itself so closely to the deck, flat side down, that after the 14 years of submergence the black powder of the charge was still in the cavity.

In cleaning the wreck every particle of the mud had to be examined with care. This was accomplished by pumping streams of water through sluice boxes, into which the mud was thrown. These discharged over screens of small mesh, so that everything would be caught that was solid.

Plate 20 (Plate 54, Fig. 1) shows the starboard side of the wreck exposed to the mud level. The ports open into the ward room on the berth deck.

Plate 21 (Plate 54, Fig. 2) shows the port side exposed to mud. On the right in the superstructure is an after 6-in. gun port. The gun was removed in 1898. The after turret with its guns are seen on the left.

Plate 22 (Plate 55, Fig. 1) shows the condition of the Admiral's quarters in the after superstructure as they were first discovered. The hanging lines are the electric wires. All the rubber parts were well preserved. In the tropics rubber loses its life quickly in the air, and yet all that rubber which had been 14 years in water seemed to have its life just as when first manufactured.

It was interesting to note the difference in the destruction wrought on the various contents of the ship by the explosion and the long subsequent submergence. Textile fabrics had practically disappeared. Rubber mats and rain coats were in good condition. Dishes and glasses were found in the afterpart of the ship, standing where abandoned. Bottles of medicine were on the storeroom shelves in perfect condition. Books had lost their covers and their leaves were stuck together, but the type was perfectly legible. Steel exposed to the water had a skin of rust only. Where buried in the mud its surface was clean. Where two dissimilar metals were in contact in the water evidences of electrolytic action were clear. A sword standing against the deck house broke when lifted, its hilt having been eaten away from the blade. Watches found on the decks were plated with iron. In a box on the main deck near the after turret had been deposited a number of filled cartridge belts with bayonets in their scabbards attached. When found, the steel from the bayonets had been transferred through the leather of the scabbards to the sur-

face of the copper cartridge shells and there deposited, cementing them together in masses.

Plate 23 (Plate 55, Fig. 2) shows the cabin after cleaning out the mud and the remains of the wooden partitions. In the work, care had to be taken when near the shell incrusted metal, since cuts made by the shells were poisonous.

Plate 24 (Plate 56, Fig. 1) shows the interior of the amidships superstructure, directly over the after boilers. The ship's gallery is seen in the right background with its range and in the oven was a pan full of beans. In fact, in going through the wreck the sensations were as those when visiting the ruins of Pompeii; it seemed uncanny to see things so exactly as the men left them and went to their doom fourteen years earlier.

Plate 25 (Plate 56, Fig. 2) gives a view of the berth deck in the ward-room. In this room were found the remains of one of the officers who had been unable to escape when the ship sank. The other body had been recovered in 1898.

Plate 26 (Plate 57, Fig. 1) shows the débris as piled up in the berth deck forward of the ward-room. Here was a part of the space used for quarters for the enlisted men. Nearly all of the berth deck so occupied was either totally destroyed or exposed to the blast of the explosion. It is a marvel that any escaped alive.

Plates 27 (Plate 57, Fig. 2) and 28 (Plate 58, Fig. 1) show other piles of débris. In Plate 28 the starboard side plating has been partly cut away by the acetylene flame.

Plate 29 (Plate 58, Fig. 2) is a view taken from the intact portion of the ship at frame 41, looking directly down into the bottom of the cofferdam. Three of the forward boilers can be distinguished. Sticking out among these is a long piece of steel, a piece of an interior bulkhead. That was the mixture that was first exposed.

Plate 30 (Plate 59, Fig. 1) is a view looking forward from frame 41 when all the mud had been cleaned off, and I want you particularly to notice the long piece of steel in the middle, turned up and to starboard. Its significance will be told later. Forward is the brace between cylinders "O" and "G" and forward of that is the bow section. Here in this portion between the bow section and frame 41, a length originally of about 92 ft., the ship's bottom was found lying horizontally for a distance of 28 ft., and then inclined up for

FIG. 1.—INTERIOR AFTER SUPERSTRUCTURE JUNE 21, 1911.

FIG. 2.—INTERIOR AFTER SUPERSTRUCTURE JUNE 25, 1911.

FIG. 1.—INTERIOR OF AMIDSHIPS SUPERSTRUCTURE.

FIG. 2.—INTERIOR OF WARD ROOM ON BERTH DECK, BEFORE CLEANING.

FIG. 1.—INTERIOR OF BERTH DECK, PORT SIDE, NEAR FRAME 43.

FIG. 2.—WRECKAGE ON MAIN DECK, STARBOARD SIDE.

a further distance, with the [illegible] of the [illegible] highest point the keel was [illegible] above the [illegible] of the keel are as stated earlier. The [illegible] of the armor [illegible] are [illegible]. All parts above the armor shelf have been [illegible].

As soon as that stage of the work had been reached, it became necessary to have the War Department [illegible] the Navy Department make the determination [illegible] the cause that led to the wreck of the Maine. Practically the entire wreck was exposed and it was so [illegible] to the War Department. The [illegible] naval officers [illegible] and ordered me to determine [illegible] the cause of the wreck of the Maine.

Plate [illegible]. Plate [illegible], Fig. [illegible] [illegible]

Plate [illegible]. Plate 4, Fig. [illegible] [illegible] frame [illegible]

Plate [illegible]. Plate 4, Fig. [illegible] [illegible] at a point near the middle of the [illegible] the outer and inner [illegible] with a [illegible]

As you know, all of the modern steel ships are made with double bottoms. In the Maine [illegible] and outer [illegible] wooden ships [illegible] which [illegible] longitudinal frames [illegible] The strake [illegible] the Maine there [illegible] keel and the [illegible] bottom [illegible]

In Plate [illegible], Plate 4, Fig. [illegible], the edge of [illegible] is the outboard edge of the [illegible] forward. In the center of the plate [illegible]

skin about 12 ft. long, composed of pieces of "B" and "C" strakes, turned up into the ship and to starboard. The edge of the garboard strake is dished upward as much as 24 in. along its outboard line between frames 28 and 31, and torn across at a butt joint between two plates, between frames 30 and 31, and the after portion pushed up about 6 in. A dish is also seen in the turned up part of strakes "B" and "C", corresponding to the dish in the garboard strake. The turned up portion of the strakes "B" and "C" when scrubbed disclosed the paint on what had been the ship's bottom intact and without a scratch. Inside the folded back piece of the outer skin was found the corresponding piece of the inner skin crumpled back in many folds. The parts of the transverse floor plates originally between the two were crumpled. The longitudinal frame directly over the middle line of "B" strake was broken about frame 28, was twisted and its forward end displaced upward and left 6 ft. above its original position.

To make the examination more complete, a hole was excavated in the harbor bottom just below the break in the ship's bottom shown on Plate 33. Plate 34 (Plate 61, Fig. 1) is a view taken in this hole, looking up at the ship's bottom. It shows clearly the dish described above.

To any one accustomed to the use of explosives in water—accustomed to see how an explosion acts under water—Plates 33 and 34 tell their own tale. There was evidently a force acting outside and beneath the ship with enormous power, but so slowly that the elastic forces of the steel of the bottom skin had time to exert themselves. The bottom was dished and rupture finally took place along the line of weakness, which in this case was the line of rivets. The steel held, the rivets gave and this force bent this large plate upward, inward and backward, breaking off the transverse floor plates between it and the inner skin and crumpling up and bending over, fold on fold, the inner skin. It was evident to all of the Board that the force acted in this way, because in no other way could that effect have been produced on the ship's bottom. I am somewhat familiar with submarine military mining. In all civilized countries, high explosives are used in these mines and I knew that no such explosive placed as close to the bottom of the ship, as would have been necessitated by the depth of the harbor where the *Maine* lay,

PLATE 58.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
BLACK ON THE STORY OF
THE "MAINE."

FIG. 1.—WRECKAGE ON BERTH DECK, STARBOARD SIDE.

FIG. 2.—WRECKAGE BETWEEN FRAMES 18 AND 41.

FIG. 1.—VIEW OF KEEL AND SIDES BETWEEN FRAMES 18 AND 41 AFTER REMOVAL OF MUD.

FIG. 2.—BOW WRECKAGE.

could have produced that effect on the *Maine,* because no high explosive could have exerted itself slowly enough to produce first the dent and then the turn-over of the plate, but would have punched right through the ship. There was no sign of a scratch on the paint on the outside, so that the hole could not have been caused by striking a solid object when the ship sank. The conclusion was inevitable that that hole was caused by some slow explosive to us unknown. I was so puzzled by it that when I returned to Havana in the evening I went to a friend, an American merchant in Havana. He had been in Havana at the time the *Maine* had sunk and knew from his business a good deal about explosives. I asked him what explosives were to be obtained in Havana at the time of the destruction of the *Maine.* He said the Spanish authorities had possession of all the high explosives then in Havana. "But," he said, "you know down here in Havana when we want to do any blasting, we make our own explosive. We just go down to the hardware store and get a certain amount of charcoal, of sulphur and of nitre and we mix this together and make an explosive of it. We put that explosive in a quarry hole and it acts so slowly that standing alongside of the place you can actually see the rock rising out." "Was there much of these materials in stock during the war?" I asked. "Yes, I was able to get all I wanted." Now, there was an explosive that would have acted in just that way.

Now, I am going to take you back again to the section, Plate 2 (Plate 44). Here is the forward boiler-room which was all blown to pieces, with the boilers thrown aft, the rear pair against and through the bulkheads separating the forward and after boiler-rooms near frame 41. From this bulkhead aft the whole of the hull of the ship below the armor plate was entirely intact. Near the bulkhead in the starboard side the armor plate had been partly displaced. On the port side of the after boiler-room hatch the protective deck had been split from frame 41 aft for a distance of about 36 ft., and the strip along the port side had been turned over, back and to port beneath the main deck, lifting that deck in its passage and tearing away one of its beams. The port side of the ship above the armor belt, from frame 41 to the after turret, had been blown out. The displaced portion of the main deck over this had sprung back nearly to place. On the starboard side little damage had been

done aft of frame 41. Aft of the amidships deck house in the starboard side is the point where the conning tower fell and forward of this a portion of the amidships superstructure was crushed down, and a part of the deck somewhat crushed in.

You can see in the section a series of transverse watertight bulkheads at intervals from bow to stern. From the bow to frame 18 is the portion of the bow section which I showed you (Plate 59, Fig. 2) as broken off and turned at right angles to the line of the keel. From about frame 18 to frame 41, the protective deck was blown out to starboard and aft as shown in Plate 8 (Plate 47, Fig. 2). Now, from frame 18 back to frame 41, all of the top of the hull above the armor belt was blown off and the sides below flattened out. The distance between the transverse frames amidships is 4 ft. The distance between the outer and inner bottom was about 3 ft., the height of the transverse floor plates. The hole that was blown through the bottom was partly directly under the 6-in. reserve magazine and in that magazine was stored from 2 000 to 3 000 lb. of black gunpowder. Evidently that gunpowder was at once exploded, and in turn caused the explosion of the black gunpowder in the 6-pounder cartridges and a partial explosion of the brown powder in the 6-in. and the 10-in. magazines. The action of the gases in expanding in the chamber formed by the protective deck and the hull, tore out the interior bulkheads, throwing the transverse bulkheads forward and aft from the point of explosion. Still expanding, a portion of the gases found a vent through the protective deck aft of frame 41, a portion demolished the hull above the armor belt between frames 18 and 41, throwing the protective deck aft and to starboard, turning back the main deck with the conning tower, and toppling the forward turret out to starboard. The bow section was nearly torn off about frame 18, one-half of its protective deck blown out with all of the hull and decks above, and the section turned as shown with the vents for the gases uppermost, as shown (Plate 59, Fig. 2).

The cause of the destruction of the ship having been determined, nothing remained to be done but to complete the cutting away of the torn parts and the removal of the wreckage from the harbor.

Plate 35 (Plate 61, Fig. 2) shows the bulkhead which was built across the hull at frame 41 to enable the after part of the wreck

FIG. 1.—WRECKAGE LOOKING AFT FROM FRAME 18.

FIG. 2.—HOLE THROUGH SHIP'S BOTTOM.

FIG. 1.—LOCATION OF OUTSIDE EXPLOSION SHOWING BOTTOM PLATE BENT INWARDS.

FIG. 2.—WOODEN BULKHEAD AT FRAME 41 AND ALONG PORT SIDE OF WRECK.

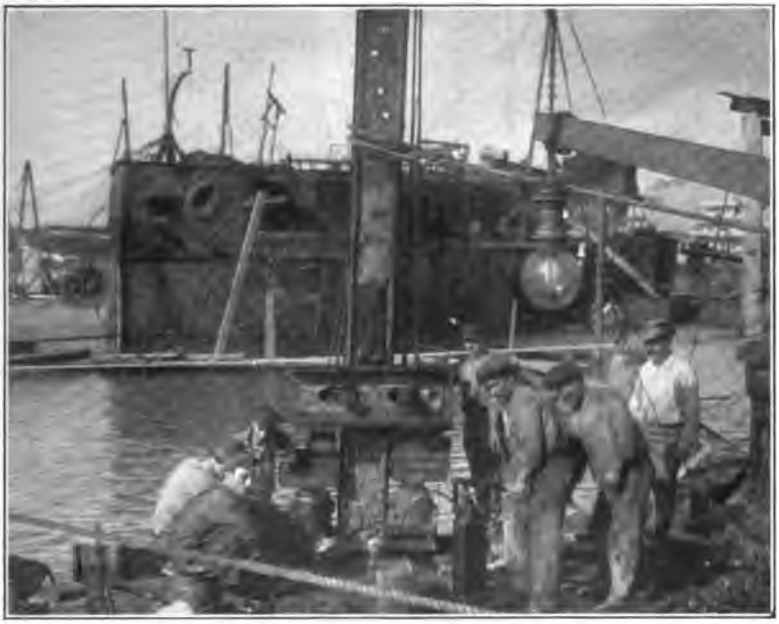

FIG 1.—STARTING A PILE WITH JACKS, WRECK AFLOAT IN COFFERDAM. FEBRUARY 21, 1912.

FIG. 2.—PULLING PILES WITH A FLOATING DERRICK.

to be floated. The bulkhead was designed to stand a pressure due to a head of 30 ft. of water. The open end of the amidships superstructure appears in the middle foreground. The bulkhead extends aft on the port side as far as the after turret, above the armor belt. The bulkhead was of heavy timber bolted to the hull and braced, and reinforced at the base by a concrete backing.

The next problem which presented itself was how the mud seal should be broken. The wreck had been imbedded in the harbor bottom for fourteen years to a depth of from 2 to 16 ft., increased during the construction of the cofferdam to 20 ft., by the overflow from the cylinders when filled by the hydraulic dredge.

The solution was made very cleverly at the suggestion of one of the assistants. Twenty-nine 6-in. holes were cut with the oxy-acetylene flame through the bottom of the ship, flanges were set in and pipes secured to the flanges and these connected with a force pump. Water was forced in until a circulation was assured under the entire bottom of the ship.

On January 26, the water was permitted to rise in the cofferdam to a depth of a few feet. Prior to this, when the wreckage forward of frame 41 had been cut away, a mud wave began to rise in the space cleared, under the pressure from the cofferdam walls. The maximum height of the wave forward of frame 41 was about 3 ft. The intact part of the hull also rose a few tenths of a foot. On February 3, 1912, the cofferdam was flooded to elevation — 24, and the water held there until February 10, when the final flooding was started. The ship rose as soon as the water had reached the level of — 19. The extra head that was required to make the final break from the clay was about a foot. The hull when afloat was a little down by the stern. That was corrected by ballasting until she was nearly on an even keel.

The next operation was to remove two of the cylinders at the end, and difficulty was had in extracting the first pile, some of the piles tried having resisted pulls up to 240 tons. After the first pile had been pulled from each cylinder, the others were removed more easily, generally with a resistance of less than 75 tons. The adherence of the clay was so great that in the operation of pulling the pile out of the clay rupture took place in the clay. The clay fill of the cylinders was removed by dredging and a gateway formed

for the exit of the floated hulk. Plate 36 (Plate 62, Fig. 1) shows the remains of the *Maine* afloat within the cofferdam and the operation of pulling one of the piles with hydraulic jacks. Plate 37 (Plate 62, Fig. 2) shows the extraction of a pile with a floating derrick.

During the entire period of the operations, the Cuban Government did everything possible to help the work. When we began to find the remains of the sailors, permission was asked to store them temporarily in the fortress of Cabana. This permission was granted and while in the fortress they were continuously in the care of a guard of honor of the Cuban army. Finally, when all parts of the wreck had been searched the total number recovered amounted to sixty-six and arrangements were made for their transfer to the United States. The Cuban authorities wrote to the President of the United States and stated that Cuba desired to show special honor to the memory of the men who had perished in doing their duty in a cause which afterwards brought about the freedom of the Island, and requested that the United States turn over to them for twenty-four hours, the remains of these men. This was done, and on the evening of March 14, they were taken to the Council Chamber of Havana which was transformed into a mortuary chapel, as shown in Plate 38 (Plate 63, Fig. 1). During the whole of the 15th the population of Havana came to pay their respects, passing in with the utmost reverence, and from time to time the more prominent citizens of Havana took their places in the guard of honor. March 16 had been designated as the date for the burial of the *Maine*, and for the transfer of the remains to U. S. S. *North Carolina* for removal to the United States. On the morning of the 16th, the *North Carolina* and the *Birmingham* arrived in port. At 10 A. M. the funeral cortege left the Council Chamber. The escort was headed by the municipal police and the municipal band. Then followed companies of sailors and marines from the *North Carolina* and *Birmingham*. The 34 caskets were borne on the shoulders of Cuban soldiers and a guard of honor from the Cuban army lined both sides of the street from the palace to the wharf. In the procession were representatives of the official life of Cuba, headed by its Vice-President. The remains were taken to the wharf and there the representative of Cuba, the Alcalde of Havana, turned them

FIG. 1.—REMAINS OF SAILORS LYING IN STATE IN COUNCIL CHAMBER, HAVANA, MARCH 15, 1912.

FIG. 2.—FUNERAL CORTEGE PASSING FROM PALACE TO WHARF.

FIG. 1.—WRECK AFLOAT OUTSIDE COFFERDAM, MARCH 15, 1912.

FIG. 2.—WRECK LEAVING HAVANA HARBOR IN TOW OF U. S. TUG "OSCEOLA," 3 P. M., MARCH 16, 1912.

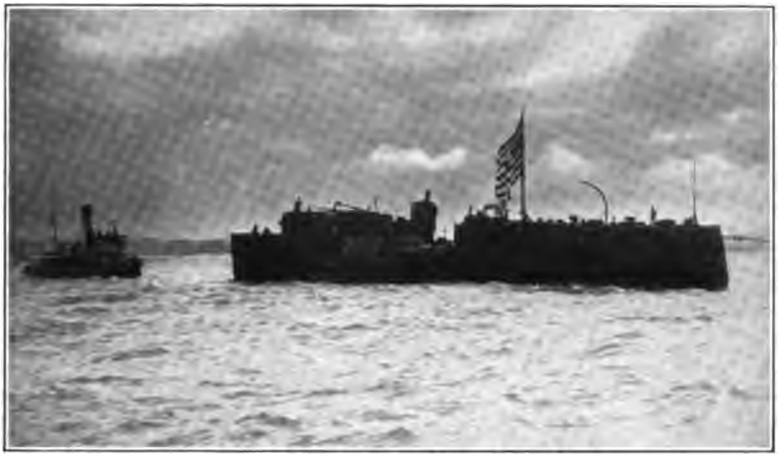

FIG. 1.—WRECK AT SEA UNDER TOW.

FIG. 2.—ABANDONED AND SINKING, MARCH 16, 1912.

over to the Chief of Engineers of the United States Army, who had been designated by the President of the United States to receive the remains from the Cuban authorities. They were then placed on the boats of our man-of-war.

Plate 39 (Plate 63, Fig. 2) shows the procession en route.

Plate 40 (Plate 64, Fig. 1) shows the *Maine* lying outside of the cofferdam, ready for her procedure to sea. Before starting for her final resting place, a jury mast was rigged and a large United States flag, furnished by the *Birmingham*, was nailed fast. The decks of the hulk were strewn with flowers by United States citizens in Havana.

There had been considerable discussion as to what should be done with this wreck. Many people wanted the wreck to be brought to the United States, doubtless in a proper spirit, and yet when you come to think of it, the interest in a short time would degenerate into mere curiosity, so that after a time this mutilated relic of a man-of-war, which for fourteen years had been the tomb of so many of our sailors and which represented an act which ultimately resulted in a change in the geography of the world, would have been regarded simply as a show.

Under these conditions, resolutions were offered in Congress, and finally adopted, to the effect that the only proper course for the United States to take would be to give the hulk an honorable burial at sea. March 16th was set for the date of the ceremony and the U. S. S. *North Carolina* and *Birmingham* were ordered to Havana for that purpose. The Cuban authorities signified a desire to take part with all of the Cuban naval ships available. Great interest was also shown by the people of the United States and of Cuba.

Plate 41 (Plate 64, Fig. 2) shows the head of the funeral procession. The hulk was towed by the U. S. Navy tug *Osceola* and attended by four other tugs to render such assistance as might be necessary. The wreck and her attendant tugs were followed by the *North Carolina* and *Birmingham,* by all the ships of the Cuban Navy and by about 80 or 90 other craft, forming a strange and solemn funeral procession. The ships, the shores of the city, the housetops and the ramparts of the harbor forts were black with people. It is estimated that 100 000 persons in all took part.

Plate 42 (Plate 65, Fig. 1) shows the wreck at sea under tow, stern foremost. The day was fair, with a fresh breeze, and the *Maine* rose to the waves buoyantly as if she had not been, for all these years, sunk in the harbor bottom. She seemed actually to rejoice in being again afloat. The progress to sea was slow and the end of the procession had little more than cleared the harbor entrance when the *North Carolina* signaled that the three-mile limit had been passed. Way was stopped and the towing lines cast off. The ships, as they came up, formed a circle a mile in diameter around the wreck.

The working party, under two of the assistants who had labored so long and faithfully in the difficult work of raising the wreck, boarded the ship, opened the sea cocks in her bottom and the gates previously made in the temporary bulkhead, and allowed the water to enter.

The ship as she lay awaiting the end was a pathetic object (Plate 43) (Plate 65, Fig. 2). We knew that the end was sure and soon, but the waiting seemed long. As the water entered, the decks came nearer and nearer to the surface, but again and again the wreck would rise on the waves to her old line of floatation. It was like the struggles of a strong life departing. Finally the bulkhead was submerged to the deck level. The hulk assumed a position nearly vertical, and sank rapidly out of sight, Plate 44 (Plate 66). As the flag touched the water, three volleys were fired from the warships and the solemn notes of "taps" sounded over the waters. As the last note sounded, and only flower-covered, swirling waters filled the site where last the remains of the battleship were seen, the whistles of all of the craft roared out a farewell and all that was left of the *Maine* sank to its final resting place six hundred fathoms down.

PLATE 66.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
BLACK ON THE STORY OF
THE "MAINE."

THE MUNICIPAL ENGINEERS OF THE CITY OF NEW YORK.

Paper No. 74.

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THE SEGREGATED BUDGET AS APPLIED TO MUNICIPAL ENGINEERING WORK.

BY FRED W. LINDARS.*

WITH DISCUSSION BY
ALFRED D. FLINN, WILLIAM W. BRUSH, JOHN T. FETHERSTON AND FRED W. LINDARS.

There is a prejudice on the part of a great many city officials and employees against the segregated budget. This is based upon a misconception of its real purpose. Some persons unthinkingly believe a segregated budget represents an effort on the part of theorists who have nothing to do with the practical administration of the city; who are ignorant of the practical needs of the city and who, in the privacy of their own offices, devise a segregated budget as an alleged remedy for imaginary wrongs.

I hope to convince you that this conception of a segregated budget and of those who are responsible for it is entirely wrong. The segregated budget does not attempt to take away administrative power but does try to provide for the needs of the city in such a way as to assure their being met. The appropriating body of the city, which is really responsible for making effective the segregated budget, is not attempting to administer departments. It is its duty, however, not only to make appropriations but, before making appropriations, to study estimates of needs so as to have an intelligent basis for action. The title of the appropriating body, namely, the Board of Estimate and Apportionment, proves this double duty. It is firstly a board of estimate and secondly a board of apportion-

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ment. The analysis of the annual estimates submitted by departments and the allowances made by the Board of Estimate and Apportionment are not made ignorantly. As a general proposition this work is the result of careful investigation and study. Recommendations are not and could not be infallible. Frequently estimates are not turned over until the last minute, thereby necessitating hurried study and oftentimes poorly considered recommendations. But as a rule analysis of estimates is made by men trained to develop certain facts and to report upon conditions and needs as stated and determined upon after a thorough investigation. Recommendations made by these men to the Board of Estimate and Apportionment, containing "cuts" under the original requests, are not reflections upon the intelligence of the officials preparing the estimates. I do not mean to say that the investigations and recommendations are faultless but every endeavor is made to be impartial and to recommend only those things which have been demonstrated as justifiable.

It is easily possible that one head of a department will request a certain force to perform certain units of work and other heads will request a much smaller and cheaper force to perform similar units of work. This does not prove that the first one is dishonest, but it does prove the first may be getting misinformation as to the market value of the services necessary to perform the work. As an illustration of this point: at the last election the Sheriff of Kings County was ordered to appoint deputies to see that the election laws were not violated. The Sheriff of New York County received similar orders. The duties of the deputies in each borough were identical. The deputies were appointed and performed their duties. In due time, the Sheriff of Kings County rendered bills for the services of the deputies at the rate of $5 per day. The Sheriff of New York County rendered bills for the services of his deputies at the rate of $8 per day. If no centralized budget-making power existed, nothing could have prevented the payment of the extra $3 per day to the deputies appointed by the Sheriff of New York County. As it happened, the Comptroller, through his Bureau of Municipal Investigation and Statistics, developed the facts and recommended to the Board of Estimate and Apportionment that appropriations in the budget for deputy sheriffs' compensation be made at the rate of $5 per day, regardless of the borough in which

they were to work. The Sheriff of New York County thereupon became indignant and stated that it had been the practice for years to pay the deputies appointed by him or his predecessors at the rate of $8 per day. While both sheriffs were entirely honest and blameless in requesting the differing rates of compensation on the ground of precedent, there was no good reason why services of this character should be paid for at differing rates in two adjacent boroughs.

The segregated budget provides specific amounts for specific purposes along natural lines of division, which have proved convenient in each department. For example, each department needs certain telephone service—supplies and materials, money for contingencies, etc.—which it can readily estimate from year to year. For each of these a specific sum is appropriated.

In New York City the various departments are required by the charter to submit estimates of their needs for the succeeding year not later than September 10th. Specially ruled and printed forms are furnished to the departments by the comptroller for this purpose. These forms are usually sent to the departments about June 1st, which allows over three months time to prepare the estimates. When the estimates are received examiners in the department of finance analyze them and make tentative recommendations, which, in turn, are submitted to the budget committee of the board of estimate and apportionment. This committee designates certain days for hearings on the estimates and recommendations. These hearings are attended by commissioners and other representatives of the departments together with the examiners of the department of finance. The recommendations are discussed and a tentative budget prepared and printed for public inspection. Public hearings are then held at which civic organizations, taxpayers and other citizens appear to argue for or against the tentative allowances. Frequently adjustments are made as a result of these hearings. The final budget is required by the charter to be passed by the Board of Estimate and Apportionment before midnight October 31st. Within five days after being adopted by the board of estimate and apportionment the budget must be submitted to the Board of Aldermen, which body is given power to reduce or eliminate any items but may not increase or add to the budget as passed by the Board

of Estimate and Apportionment. Action by the Board of Aldermen is required to be taken before November 25th. The budget is then submitted to the mayor, who may veto any action taken by the board of aldermen, but that body by a three-fourths vote may pass the budget over any veto of the mayor.

Engineers in the city service should take a vital interest in the segregated budget. They want to know that the budget makes provision for the employees necessary to carry out plans prepared by them. A high-grade draftsman, or a high-grade engineer, may be desired. In a segregated budget the specific rates of salary are stated which are necessary to secure the desired services. Under the old plan of "lump sum" appropriations everything was indefinite. As engineers, you want to know that the actual labor and material required to perform work planned have been provided for in the budget. If the money to pay for the labor and materials is hidden in "lump" appropriations, the engineers have no assurance that the money so provided will not be diverted to channels other than intended by them. A possible misuse of funds is prevented through segregation, and engineers can unhesitatingly take definite advance steps toward carrying out their plans immediately after the budget is adopted. Segregation not only provides a basis for adequate financial and accounting control, but it also gives to the administrator or engineer a sense of security that the projects provided for through segregation will be carried on. Without segregation there could be no such assurance.

Commitments to favorite contractors for huge quantities of materials and supplies, more than possibly could have been used, and which may have depreciated or become obsolete, flourished under the non-segregated budget. Such practices while still possible are made so difficult through segregation as to be almost eliminated. In the latter part of 1903 about 3 300 brass curb cocks were received at the Twenty-fourth Street pipe yard of the Department of Water Supply. In 1908, five years later, 3 200 of these same cocks were lying undisturbed in their original resting place. This sort of thing is made more difficult under a segregated budget because more accurate estimates of needs must be made and specific allowances made therefor. In the old days, a head of a department might request money to purchase an automobile for his engineering bureau.

This money, if allowed by the board of estimate, might be included in a large "lump sum" appropriation for the department. It was not only possible, but very probable, that instead of purchasing the automobile for the use of the engineering bureau, some fine mahogany furniture or expensive rugs were purchased to decorate some other bureau's offices. This could not have been done under a segregated budget, because a specific appropriation is made for the purchase of an automobile for the engineering bureau. Such an appropriation could be used only for the purpose specified unless the head of the department first requested the Board of Estimate to transfer the money to some other account.

Before segregation was made a reality a head of a department could request appropriations for carrying out certain set policies, and the Board of Estimate would provide the necessary funds combined with appropriations for numerous other purposes. The departmental head, however, was not compelled, as he is to-day, either to expend the money for the purposes provided or request a transfer. In those days, he could expend the money in almost any way he saw fit.

Segregation gives the best results to the city for the least money. Detailed estimates are required to be submitted by the various departments. If details were not required, the municipal engineer would have no incentive to search through his own bureau to ascertain its needs and to find out what he really has on hand. The mere fact that he is compelled to furnish detailed information makes it necessary for him to study his needs and to plan carefully for the year's work. A more intelligent estimate as to the probable cost for conducting the year's work is therefore obtained.

Under the old plan the chief clerk, or someone delegated by the head of the department, would sit down behind closed doors and prepare an estimate based upon his best guess. For the engineering bureau, he would probably say that a certain number of engineers, draftsmen, etc., were required. This may have been based upon knowledge he required from the engineering bureau, or it may have been based on anything. If the engineer is required to study the needs of his bureau, he can readily support, with exact information, any request that he may make.

It is a well-known fact that when "lump sum" appropriations

were made, as much thereof as possible was frequently held back for political purposes until the fall of the year. This was particularly true in times of closely-contested elections. The work of the department may have been allowed to lag all during the spring and summer months, and when fall came on and primary times drew near, laborers by the score were placed on payrolls and paid out of these "lump sum" appropriations, regardless of whether or not there was any work to be done. Indeed, many instances have been known where men who did not perform any work have been put on payrolls during the month or so preceding election times. When pay day came around, they would call for their money, and, in some instances, they even had the audacity to send for their money. This was a common practice, but, under the segregated budget, has been greatly minimized.

Supposing a chief engineer, before the segregated budget became effective, had laid out his plans for a year. He knew what he needed—engineers, draftsmen, rodmen, laborers, materials, etc. He knew he needed broken stone, cement, etc. He knew how many laborers he needed. This was in the good old days before the distinction in the budget between personal service and supplies and materials. "Lump sum" appropriations were provided to include all of these things. It so happened that a closely contested election was on in a section where the head of this department had some political interest. He thereupon decided that the plans prepared by his engineers could wait, even though the money had been provided to carry them out. Instead of carrying them out, however, the money was left idle until the month before election, and then hundreds of men were taken on so that their votes could be obtained. Everyone who could help was put on the payroll.

Municipal engineers do not want this sort of condition to exist. They want to "make good" for their own reputations. If their future must be blasted through political machinations, I believe, you will agree with me in saying they ought to quit. One of the biggest helps to a municipal engineer is the segregated budget. Estimates of carefully planned needs must be prepared and submitted to the board of estimate and these needs must either be allowed or some excellent reason given why they are disallowed. Plans are first conceived by the municipal engineers. If the head of the

department deems it expedient to request appropriations to carry out the plans, and the board of estimate and apportionment is in a receptive frame of mind, a specific appropriation is made for that purpose and for that purpose only, and the carefully wrought plans of the engineer are thereby safeguarded.

Under the old "lump sum" appropriations the head of a department could engage almost any kind of a force he might desire and also change it at his pleasure. With the segregated budget and its schedules of salaries and wages each position is fixed and is virtually a separate appropriation which can only be modified by the board of estimate and apportionment at the request of the departmental head.

Before the principle of monthly or weekly *pro rata* expenditures from salary and wage appropriations was adopted in the segregated budget, appropriations were frequently wasted. Now, millions of dollars are returned to the city treasury through unexpended balances. The amount reverting to the general fund from salary and wage appropriations for 1908, prior to the adoption of the *pro rata* expenditure principle was $300 000. For 1909 it was $1 060 000 and in 1910 it amounted to $1 941 000. Such a practical working out of a principle proves conclusively the need for such provisions.

This illustration, however, is not the only good result of scheduling and restricting a department to a *pro rata* expenditure. It assures the muncipal engineer that the money provided for him cannot be diverted without action by the board of estimate and then only after a thorough investigation has been made and a favorable report is rendered by the comptroller to the transfer for other purposes.

One of the old problems for the municipal engineer was to know how to obtain requisite help. Politics usually dictated who would be employed, regardless of the actual requirements. Under the segregated budget, engineering forces are being provided for adequately. Previous to segregation, engineers seldom had an opportunity to plead for their needs before the board of estimate and apportionment. Now, it is essential that they appear in order that their requests may be supported through the presentation of facts describable only by themselves.

While it is undoubtedly true that segregation may be carried out too far, New York's present budget does not carry segregation even as far as it might expediently. To illustrate: a chief engineer

of highways feels responsible for the condition of the highways under his jurisdiction. The present budget provides for the Bureau of Highways an appropriation for supplies and materials. This appropriation may have been predicated on information furnished by the engineering bureau, showing the quantities of sand, cement, road oil, granite blocks, etc., required for the ensuing year. The head of the department, however, instead of using this appropriation for the purposes for which it was allowed might use it for the purchase of other kinds of material and supplies not needed by the engineers. The material for repairing pavements not being forthcoming, the chief engineer would be unable to carry out his plans. This could not occur if the appropriation for supplies and material were segregated so as to provide for the necessary highway materials, office furniture and equipment, and other supplies and materials separately.

The segregation of corporate stock or long term bond expenditures has been very helpful in controlling expenditures for construction work. Omnibus authorizations are no longer made. The funds necessary to build a sewer are provided specifically for that purpose. These funds cannot be used for building a bridge. General authorizations were formerly made for sewers in each borough. Under the segregated plan, provision is made for each specific sewer, thus preventing dishonest diversion. Under the old scheme, an appropriation would call for the general improvement of parks, walks, driveways, etc., including mozaic tiling under the archway of a bridge in the parks. The entire appropriation could have been spent for the mozaic tiling. Now, each thing is specified.

The old dock fund, which was administered by the department of docks and ferries for construction purposes and amplified from year to year, could be used for almost anything. Salaries and wages and supplies and materials for both construction and operation and maintenance were all paid out of this fund, as were also charges for drinking water, towel supply and scores of other things. Now, it must be foreseen how the money is to be spent, and the appropriation is segregated in accordance with definite plans. Such plans, for example, may have been drawn by municipal engineers for certain dock improvements—the work of months. A new commissioner comes in and the plans laid before him, not meeting with

his approval, are turned aside. The work of the municipal engineers was thus wasted. Under the present scheme, once an authorization is made for specific improvement and plans drawn therefor, an incoming commissioner cannot divert the fund from the original purpose specified. He must either carry out the plans indicated in the authorization or obtain discredit for an idle and wasteful administration.

THE MAKING OF A SEGREGATED BUDGET.

Most American cities have, for many years, conducted their financial housekeeping on a budget basis. The methods employed, however, have been loose and inefficient. Instead of being used as a means for apportioning their funds according to the various needs of the community and insuring their actual application thereto by affording a basis for scientific accounting and auditing, the budgets of many American cities have too often been the means of hiding corruption. The making and passing of the budget has frequently been a carnival of log rolling, each alderman or commissioner inserting items for the special benefit of himself or his constituents and refusing to vote for the items inserted by his fellow-legislators unless they voted for those in which he was interested.

The making of a scientific municipal budget was first undertaken in 1906 by the City of New York. The task was approached by way of the health department, that branch of the city's service so closely related to its well-being. The functionalized and segregated budget plan worked out for that department was so successful as an object lesson that the plan was soon extended to all departments of the city. Similarly New York City was the first to institute real public hearings on a tentative budget. In January, 1910, the Chicago city government adopted a functionalized segregated budget built on the New York plan with the further improvement of standard account titles. Milwaukee was the next to fall into line and Philadelphia has expressed the intention of adopting the idea. Officials of other cities throughout the country are now rapidly becoming interested in how to improve budget methods in their own communities.

STANDARD FORM OF BUDGET.

Effective control over expenditures depends largely upon the care with which provisions are made to render ineffective the methods

which have been employed by administrators to circumvent the implied purposes of appropriations. Since an analysis of the requirements of the various departments of a city will develop many elements in common, methods of standardization have been devised which render possible the highest degree of control and stability in the method of preparing the budget.

Standardization of a city budget reduces to a definite fixed classification all of the things or objects of expenditure for which a city spends money. These are usually termed standard accounts. Once having determined the amounts required according to objects of expenditure the next step is to ascertain what public services are to be secured from the expenditure. These public services are known as "functions" and should be shown in a standard budget grouped under departments or other organization units. For example, a health department may perform several functions, such as milk inspection, sanitary inspection, child hygiene, etc.

By means of such an arrangement a clear and comprehensive picture of the various municipal functions and activities is obtained and a basis made available for judging understandingly the adequacy or inadequacy of appropriations. Not only are the appropriations for each function shown thereby but also what services or things must be provided in order that such functions may be performed.

After working out a segregation it should be standardized and not deviated from thereafter, because the comparisons thus afforded between functions, sub-functions and objects of expenditure become of more significance and value from year to year.

It should therefore be made mandatory, through charter provision or ordinance, for the appropriating body to prepare each year's estimates and also pass the budget according to the standard adopted. Besides making possible comparisons between like appropriations from year to year, simplifying and improving the accounting, auditing and reporting methods, the adoption by a city of a segregated and standardized budget makes very difficult the former custom of including "jokers" under the cloak of appropriations for various and indefinitely stated purposes.

A classification under which a tax budget of the City of New York may be logically grouped and which is adaptable to almost any city is as follows:

1. Personal service:
   (*a*) Salaries—regular employees,
   (*b*) Salaries—temporary employees,
   (*c*) Wages—regular employees,
   (*d*) Wages—temporary employees,
   (*e*) Fees and commissions.
2. Supplies:
   (*a*) Food supplies,
   (*b*) Forage and veterinary supplies,
   (*c*) Fuel supplies,
   (*d*) Office supplies,
   (*e*) Medical and surgical supplies,
   (*f*) Laundry, cleaning and disinfecting supplies,
   (*g*) Refrigerating supplies,
   (*h*) Educational and recreational supplies,
   (*i*) Botanical and agricultural supplies,
   (*j*) Motor vehicle supplies,
   (*k*) General plant supplies.
3. Purchase of equipment:
   (*a*) Office equipment,
   (*b*) Household equipment,
   (*c*) Medical and surgical equipment,
   (*d*) Live stock,
   (*e*) Motorless vehicles and equipment,
   (*f*) Motor vehicles and equipment,
   (*g*) Wearing apparel,
   (*h*) Educational and recreational equipment,
   (*i*) General plant equipment.
4. Materials:
   (*a*) Highway materials,
   (*b*) Sewer materials,
   (*c*) Building materials,
   (*d*) General plant materials.
5. Contract or open-order service:
   (*a*) Repairs.
   (*b*) Light, heat and power service:
      (1) Lighting streets and parks,
      (2) Lighting public buildings,

(3) Power,
(4) Heat.
(*c*) Janitorial service.
(*d*) Transportation service:
(1) Hire of horses and vehicles with drivers,
(2) Hire of horses and vehicles without drivers,
(3) Storage of motorless vehicles,
(4) Storage of motor vehicles,
(5) Shoeing and boarding horses including veterinary service,
(6) Hire of automobiles,
(7) Carfare.
(*e*) Communication service:
(1) Telephone,
(2) Telegraph, cable and messenger.
6. Contingencies.
7. Fixed charges and contributions:
(*a*) Debt service:
(1) Interest,
(2) Redemption,
(3) Sinking fund instalments.
(*b*) Rent,
(*c*) Pensions,
(*d*) Insurance,
(*e*) Care of dependents in private institutions,
(*f*) State taxes,
(*g*) Advertising.

It is desirable that a minimum of discretion be exercised by administrative officials in determining under what classification a given expenditure should be charged, because experience shows that several different officials will sometimes charge an item to several different accounts—each official giving a good reason for his decision. Definite schedules showing the items chargeable to each account title should therefore be prepared, printed and distributed throughout the departments to all employees who prepare purchase requisitions, audit vouchers or keep accounts. The schedules should contain in detail a list of every kind and class of service or thing for which the city spends money, arranged both alphabetically and according to accounts chargeable.

These schedules when prepared should be codified so that each kind and class of service or thing can be readily expressed through the use of symbols. This may be done, as in Chicago, by using numerals to designate departments and functions; letters to designate the standard accounts, and numerals again for the items chargeable to the several accounts. Another method is the Dewey decimal system of library classification. As an illustration of the Chicago scheme, 24 E 156 might denote absorbent cotton for the bureau of child hygiene in the health department—the numbers 24 to 25, inclusive, denoting health department and 24 the bureau of child hygiene, "E" denoting the standard account "supplies" and 156 denoting absorbent cotton. The Dewey system is advocated by the President's Commission on Economy and Efficiency, and is being successfully operated in several departments of the United States Government. The simplicity and elasticity of this system as applied to a schedule of supplies is indicated in the following illustration:

A.—Supplies,
A 1000.—Provisions,
A 2000.—Forage and other supplies for animals,
A 3000.—Wearing apparel,
A 4000.—Fuel.

Extending this method further, "provisions" would be subdivided into further classifications, for example:

A 1100-1199.—Meat, fish and fowl.

BEEF:

A 1110.—On the hoof,
A 1111.—Dressed in carcass.

VEAL:

A 1120.—On the hoof,
A 1121.—Dressed in carcass.

A 1200-1299.—Dairy products and eggs.

MILK, FRESH:

A 1210.—Cow's milk,
A 1211.—Cow's milk modified.

PRESERVED MILK:

A 1220.—Condensed milk,
A 1221.—Evaporated milk,

and so on *ad infinitum* for each classification regardless of the number of classes or the detail involved. Extended so as to include departments or other organization units and the functions performed by each unit, the code designation D H 11 A 1000 would represent (D H) department of health, (11) hospital service—care of patients, (A 1000) supplies—provisions. The adoption of a definite code system will not only furnish an excellent basis for requisition and audit, but will simplify the compilation of statistics for use in preparing budget estimates and in making public reports.

The compilation of statistics by use of code symbols is best accomplished by mechanically punching the code symbols in cards and then sorting and tabulating the cards with electric sorting and tabulating machines. Information can now be acquired in this manner which a few years ago was only obtainable through laborious clerical effort.

Importance of Salary and Wage Schedules.

Salaries and wages of officials and employees represent a very large part of the city's budget—often ranging from one-half to two-thirds of the total. Much political intrigue and jobbery are frequently carried on through failure of the appropriating body to provide for adequate control over appropriations of this character.

To circumvent and minimize, as far as possible, the misuse of salary and wage appropriations, it is essential that they be classified in four general groups, namely:

1.—Salaries, regular employees;
2.—Wages, regular employees;
3.—Salaries, temporary employees;
4.—Wages, temporary employees.

Groups 1 and 2 represent remuneration provided for employees engaged during the entire year (including or excluding Sundays and holidays, as the case may be), regardless of season, weather or the quantity or exigency of the work to be done. Groups 3 and 4 represent remuneration provided for employees who render temporary service dependent upon season, weather or the quantity or exigency of the work to be done.

Under groups 1 and 2 would be listed in detail the number of incumbents, rate and amount provided for each class and grade. To illustrate: Under salaries, regular employees, might appear

1 director	$5 000
1 chief clerk	2 500
2 clerks @ $1 800	3 600
2 bookkeepers @ $1 800	3 600
2 stenographers and typewriters @ $1 200	2 400

and under wages, regular employees,

1 foreman of mechanics	@ $5.00	per day	(365 days)	$1 825.00
2 carpenters	@ 5.00	" "	(313 ")	3 130.00
3 plumbers	@ 5.00	" "	(313 ")	4 695.00
1 mechanical engineer	@ 4.50	" "	(365 ")	1 642.50

Similarly, under groups 3 and 4, would be listed each class and grade and rate of compensation. Instead, however, of showing the number of incumbents in each class, the schedule would show the time of service based upon the estimated "man" days, weeks or months required for each class and grade of service. To illustrate: under salaries, temporary employees, might be listed

Accountants	@ $2 100	per annum	(36 months)	$6 300.00
Stenographers	@ 1 000	" "	(18 ")	1 500.00

and under wages, temporary employees, might be listed

Foremen	@ $5.00	per day	(60 days)	$ 300
Calkers	@ 4.00	" "	(60 ")	240
Laborers	@ 2.50	" "	(1 150 ")	2 875

Such grouping will permit the director or other department head to utilize his appropriations for temporary employees as the requirements of the work demand. He could, for example, if the above illustrations were actual appropriations, engage six accountants for six months, twelve for three months or twenty-four for one and one-half months, or, in the case of wages, ten laborers for 115 days or one hundred laborers for eleven and one-half days. In fact, he would have entire discretion as to the number of incumbents and length of service for each temporary position, so long as the total number of work units expressed in days, weeks or months were not exceeded.

In reply to objections that the administrator should not be tied down to the extent of losing entire discretion in the application of his appropriations, such allowances for temporary employees should be granted, thus providing the elasticity needed to conduct efficiently the work of his department.

Such elasticity as may be necessary in the standard accounts other than salaries and wages may be provided subsequently by *inter se* transfers.

Functionalization.

Segregation of appropriations within a department or other organization unit according to functions, subfunctions and standard accounts is the only means of affording adequate publicity to the financial provisions made for carrying on each function. It enables one to ascertain readily, for example, what means are made available for conducting a campaign for the reduction of infant mortality, for milk depots, for visiting nurses, for child hygiene; or to furnish a supply of water, subdivided as to administration, collection and storage, pumping, distribution, analyzing and testing, etc.

The plan of functionalization referred to may be extended so that departments or other organization units can be grouped according to the general functions they perform for the community as a whole. For example, the police and fire departments, building inspection, etc., may be grouped under "public safety." This idea has been advocated for a number of years by the Bureau of Census in Washington, and a number of cities in the United States have adopted it in presenting financial reports. General government, public safety, health and sanitation, care of the dependent, delinquent and defective are some of the broad functions each municipal corporation performs for its community. This kind of functionalized grouping of budgetary appropriations, however, can be best shown in the form of a summary attached to the budget.

Preparation of Budget Estimates.

To facilitate the preparation of a standard form of budget, it is essential that estimates be prepared in accordance with the standard account titles and functions. Uniformity should be strictly adhered to. Standard forms should be designed for departments or other organization units to be used by them when sub-

mitting their estimates. Careful thought should be given to designing these forms. What character of information will best shed the light upon requests for appropriations and what is essential to provide the best basis for investigation, are the principal considerations to be borne in mind. The number of different forms should be as few as possible, so as to simplify the work of preparing the estimate. Estimates for salaries, regular employees, for example, should be submitted on columnar ruled forms arranged to show: (1) title of positions; (2) rate; (3) estimate; (subdivided as to (*a*) number of incumbents, (*b*) total amount, (*c*) salary increases, (*d*) new force; (4) comparison of estimates with latest payroll condition. Estimates for salaries, temporary employees, should show the title of position and rate, the number of days, weeks or months estimated to be required and the amount necessary to pay therefor, also comparative data for the previous year.

The principle of requiring officials to show, not only the details of what is wanted, but also supporting comparative data whenever possible, admits of intelligent analysis and renders more simple the task of the appropriating body. Another valuable feature of this principle is the tendency it has to obviate careless and hastily considered estimates. It is hardly possible to prepare a logically supported estimate unless an intelligent analysis has been made of the expenses of previous periods. Estimates for supplies and materials should show in detail each kind, class, quantity and probable cost. Units of work should be shown, such as the number of square yards of the different kinds of pavement to be maintained, the number of milk depots to be operated, etc. If stores accounts have been kept, the consumption, both as to quantity and amount, during the previous year and the nearest six-months period should be shown. Inventories at the beginning and end of the previous year, together with the latest one available, should also be set forth. If stores accounts have not been kept, expenditures, for the previous year and the nearest six-months period, together with inventories, if available, furnish the next best information with which to support estimates.

Expenditures of the previous year are oftentimes useless as an aid in determining in advance the needs for the succeeding year. For example, purchases of supplies or materials in large quantities may be included in the expenditures for a given period, although

actually consumed in subsequent periods. It is apparent, therefore, that expense accounting and stores accounting are of primary importance in efficient budget making. Through such mediums only is it possible to obtain an accurate idea of the cost of conducting each function or activity. What was obtained and what was expended in obtaining it is information necessary in determining the desirability of expansion or contraction through larger or smaller appropriations.

Departments should be given ample time in which to prepare their estimates. Printed forms should be in their hands several months in advance of the time set for passing the budget. Ample time should also be allowed for investigation of the estimates and the preparation of a tentative budget for public discussion before the appropriating body. Budgets should not be made in secret. The widest publicity is desirable, and intelligent expressions of approval or disapproval of every item should be encouraged. Estimates should be printed for distribution. In large cities separate pamphlets should be printed for each of the large departments, because individual criticism is usually concentrated on one particular department or function.

Passing the Budget.

The departmental estimates having been made available in printed form, it is always desirable that the fullest publicity be given thereto. While it is true a department head should know more about the needs of his department than anyone else, local political conditions are often such that the time of such executives is mostly consumed with matters other than the actual conditions within their respective departments. They must rely on reports of subordinates, and these latter sometimes lack sound judgment as to the needs of even their particular divisions. They often fail to sense the comparative importance of the several functions or divisions of the department. Even when a department head is himself thoroughly informed as to the conditions within his organization, he, too, sometimes lacks the proper perspective as to how the amounts should be apportioned between the several functions of his department. It is of much importance, therefore, that either the comptroller or the appropriating body should directly or indirectly conduct a detailed investigation to determine the adequacy or inadequacy of departmental requests. Such investigations should, of

course, include careful consideration of results accomplished the previous year with the funds allowed, unit costs, and the quantity and quality of service needed to be rendered the ensuing year.

The budget of a city when once adopted remains in force for an entire year. It directly affects in some way the daily life of each person residing therein. The spirit of the laws upon which our entire governmental structure is erected demands that, before appropriations are formally passed, citizens be given an opportunity to appear before the appropriating body and state any objections they may have. For this reason, as soon as the estimates have been examined by the officials charged with that duty, it is desirable that a tentative budget be prepared and public hearings held thereon. To insure an adequate interest in such public hearings, the dates and hours thereof should be given publicity in the local press at least two weeks in advance and copies of the estimates or tentative budget generously distributed. If a large number of citizens desire to be heard, a rule may be adopted whereby spokesmen only shall be recognized.

As a means to help inform the public of the vast details of a city's business, New York, in 1910 and in 1911, held what were termed "budget exhibits." They were kept open for one month immediately preceding the passage of the budget in each year. Facts and figures graphically displayed, intermingled with physical objects, informed the visitor of the city's activities—what had been and what was expected to be done with taxpayers' money. Through this means concrete information respecting estimates was made available to everybody for effective use at public hearings.

It has too frequently been the custom for a budget to be made up in "star chamber" sittings by a select coterie of political office-holders controlling the city's purse strings, and then passed by a council or other legislative body sitting in "executive session." That day is rapidly passing and the people are insisting that public business be conducted publicly.

The chief financial officer may be sincere and progressive in his efforts to better municipal conditions and feel that he, and perhaps a few close advisers, alone know what is best for the city. Therefore, he may refuse to take the public into his confidence, lest his pet plans receive the wrong kind of publicity and his efforts be brought to naught. He may even refuse until the last

[illegible] of the legislative body charged by law with passing judgment upon the budget. Such a stand on the part of any public officer is ill taken. It has been demonstrated again and again that the public, when properly informed, may be relied upon to take wise action.

Many cities do not pass their annual budget until after the beginning of the fiscal year to which it relates. The annual expenditures of a city necessarily begin on the first day of its fiscal year. Unless the appropriations have been passed, such expenditures are made without adequate legal authority. Dilatory methods tend to confuse both accounting and auditing. It is desirable that ample time be provided between the final passing of the budget and the beginning of the fiscal year, to permit the administrative officers to become thoroughly familiar with the provisions thereof, and also to permit the opening of new appropriation accounts.

It is almost impossible to foresee all contingencies which may arise several months in advance. Transfers from one account to another are therefore necessary from time to time. By compelling department heads to ask for transfers, attention is at once directed to the fact that their contemplated expenditures exceed the amount allowed, and the question which naturally arises and must be answered is, why? For this reason there will develop a tendency to exercise more economy in expenditures and keep within the original allowance if possible. Unless restrictions are imposed, however, the transfer privilege is sure to be abused. It is, therefore, well to prescribe in the bill that no transfer shall be made from a "salaries" account to any other than a "salaries" account. Similarly, with respect to "salaries, temporary employees," "wages" and "wages, temporary employees," "supplies and materials," etc.

Instances have been known where a department head exhausted practically all of his appropriation for "wages" within the first few months of the year and then requested an additional appropriation or transfer.

Departments should be required to prepare their payrolls in accordance with the items listed under appropriations for salaries or wages, regular employees, and be restricted to a monthly or weekly *pro rata* expenditure of the total appropriation for each item, according to the frequency of payment. By this means, all accruals

resulting from the fact that positions provided for were not filled for the entire year or on account of deductions for absences or other causes would revert automatically to the general fund of the city.

Adminstering the Budget.

The most efficient plan for budget making may be of no avail unless the budget, after it is passed, be efficiently administered. The restrictive provisions of the budget are there to be enforced. Claims against appropriations should be allowed only when they constitute proper charges against such appropriations and amounts set forth in the budget, should not be permitted to become over-encumbered with liabilities. The segregated budget provides the best possible assurance for obtaining the necessary funds to carry out well-known plans and purposes, and it gives citizens and taxpayers an opportunity for an intelligent understanding of how the money they have provided is to be used. Surely, they are entitled to that. They are entitled to know and they should know how their money is being spent, and segregation gives them that information. At the same time it provides the efficient administrator with the best possible medium for throwing off any undue political pressure which may be brought to bear upon him for the diversion of funds to channels other than those specified. Municipal engineers should co-operate with the budget makers. Facts are essential and no one is better qualified to furnish facts than the engineers. They can assist in scientific budget making more effectively than others, and through shedding the light on their estimates prove the effectiveness of their work and receive the hearty support of everyone concerned.

DISCUSSION.

ALFRED D. FLINN, M. M. E. N. Y.—Mr. Lindars has certainly presented to the Society an interesting statement on a subject which closely affects all our activities as municipal engineers, one that deserves our careful discussion. I think it is a subject on which we could help the City administration just as we are endeavoring to help it now in the standardization of engineering salaries and grades.

Mr. Lindars' paper is open for discussion, and he wishes me to say that there are here for examination by the members present a number of forms, which may be seen during the social hour, and will be found upon the desk.

The paper certainly has raised many questions in my own mind and I doubt not in the minds of all who listened to it, and particularly engineers at the heads of older departments or boroughs who have to work very hard on the budgets and the statements which support them.

WILLIAM W. BRUSH, M. M. E. N. Y.—The subject of the Budget is one, as Mr. Lindars has said, which interests all members of the Municipal Engineers, both as engineers and individuals; and we ought to be grateful to Mr. Lindars for the time given in preparing and presenting to this Society a statement of the reasons for a segregated budget and the advantages that come to the City and to the engineers from such a budget.

In the actual carrying out of departmental work under a segregated budget, there are a good many things which come up which naturally would not be covered by Mr. Lindars in a general description. Few of those members of the society who have to do with budget making and with administration question the advisability of a segregated budget for a city. It is mainly in the rules and regulations that are laid down, first, in the preparation of such a budget and, second, in the administration of it, that difficulties have arisen. Possibly, from the viewpoint of the engineer, one cause of difficulty is that the segregated budget to date has been mainly evolved and laid down by the accountants, and the engineers have had but little opportunity to be heard, and usually only after the regulations covering budget making have been fixed. Sometimes the engineer's suggestions have become effective later, and sometimes not. It has appeared to some that if engineering advice were asked in the preparation of the segregated budget and in the rules to be applied in carrying out that budget, that possibly we would get a little happier result, and save some money to the City, and also save some worry on the part of a good many engineers—some

who are looking for increase of salary and some who are looking to get their work done efficiently and expeditiously.

Taking up the first part of the budget, that is, the salary part, which is probably more familiar and more interesting to most of our members, the segregation by functions and schedulizing of positions would create little difficulty if there were some flexibility given in the changing of the schedule where such change did not affect the total amount of money or the number of positions. To illustrate the above statement: In the present budget and under the rules laid down for the application of that budget, if in any given department there is a position vacant, due to resignation or removal of the incumbent, that position can only be filled by an employee holding the same title and the same rate of pay as the former incumbent, unless action is taken by the Board of Estimate and Apportionment. Cases frequently arise where the budget provides for a change in title of an employee. When the time that the budget goes into effect arrives, Civil Service complications may prevent the employee receiving the title as provided for in the budget. He, therefore, receives no salary until the budget is changed by the Board of Estimate and Apportionment, which generally takes about two months. About the time that the change is made there may be, and frequently we have found in practice that there is, a change in the Civil Service conditions so that the man can then get the salary and position originally provided for in the budget, and the budget having been changed by the Board, it has to be changed back again. Those are cases merely of change in title and not of rate of pay. Take the case of where a man has resigned; there may be no Civil Service list that is available to fill the position at the rate of salary that is fixed. There may be men available by transfer, or otherwise, who could properly do the work, but should there be a change in the position by title or in rate of pay, or possibly both—and I refer to change in lowering rather than raising the rate of pay—under the present rules you have to go to the Board of Estimate in order to get that change authorized. Meanwhile, if you have made provision for a transfer of a man from another department to fill the position, he gets tired of waiting, and gets transferred somewhere else. Then you have your position changed and nobody to fill it, and you have to start in over again. The change that would obviate this would be to allow the head of department to change the title of a position, or change the rate of pay, provided that he did not increase the rate of pay for the position, and also allow the head of department to reduce the rate of pay for a position, or both change the title and reduce the rate of pay of that vacant position, provided he did not increase the num-

ber of positions or increase the rates of pay of either positions beyond what had been allowed in the budget for that department. That sounds complicated; probably I have not presented it clearly. Let us assume we have a clerk at $1 200 who resigns; that he was receiving that rate of pay due, possibly, to length of service, and that upon his resignation or removal for any cause it is not necessary to have a clerk at $1 200; that the work can be done by a clerk at less salary—say, $750. Now, under the present budget schedule, you cannot employ a clerk at $750, but you must employ one at $1 200, or go without the services of a clerk until a change in the budget has been made by the Board of Estimate, and you cannot use the difference in salary to apply to some other salary or to a new position. I am not advocating that the commissioner should apply it to a new position, but I am advocating that he should have the power to modify where such modification would not increase the salary roll of the city. Most of the changes that are asked for, as far as I can judge, are those which could readily be made by the head of department without any action by the Board of Estimate and Apportionment, and without taking from the Board of Estimate any of the control which they now practically exercise. To illustrate again, if you have a schedule which calls for a laborer at $2.50 a day, and you want to appoint a coal-passer at $2.50 per day; if you appoint a coal-passer, he does not get paid until the Board of Estimate changes the schedule line from laborer to coal-passer. The above are some of the controls which seem to be unnecessary.

Leaving the question of salaries and taking up supplies: We are now asked to guess as to how much, in the way of supplies, is needed under each individual item, thus making apparently exact estimates as to how many gallons of oil, how many plank of one size or another, and how much paint of different kinds we require. That means that we are simply taking a good deal of time in the preparation of the budget; a good deal of time is spent by the examiner in going over figures, and, after it is all done, there is practically no control by the Board of Estimate. If the allowance for supplies was based upon the consumption of supplies in previous years, expressed both in units of material, price, and resultant cost—in other words, to illustrate, if we find that in the year 1911 we used $10 000 worth of supplies, those supplies being given in such detail as the Board of Estimate desires from the records of the Department, the stock on hand also given in detail, an explanation given if there is any necessity for increasing or decreasing from former years, and if any particular feature of the work for the following year would cause an increase or decrease in the amount of supplies required, that would be stated. From these statements could be determined readily the amount, in dollars and cents, required for supplies for

the following year, and you would not have to guess the number of gross of screws, the number of plank you require, the number of fence posts or the number of feet of fence wire, and the number of spools of thread for repairs to awnings, which is one of the standard jokes of the present schedule. Such guesses would be eliminated and save time to the Department and to the examiners looking over the schedule; and I think, therefore, that if consideration was given to some of the means of budget making and application of the budget after it is made, that the difficulties that are found in carrying out the work under the budget would be greatly diminished, and we would appreciate more of the blessings which the City derives from the segregated budget, as shown by Mr. Lindars, instead of losing sight of those blessings in the ills and troubles that we find in carrying out the work under the segregated budget as at present applied.

Fred. W. Lindars.—If I may answer Mr. Brush—the first idea he advocated is that of giving suggestions to the Board of Estimate and Apportionment, or budget committee, as to form of estimates and form of budget. I am sure such suggestions would be very acceptable. It is true, perhaps, that City Engineers have not been asked specifically for ideas or information as to how the budget should be set up, but I am sure that the budget committee of the Board of Estimate would be very glad to receive suggestions as to improvement in either the form of estimates or the form of budget.

As to the amendment of budget schedules in salary and wage appropriations—the idea, I think, is summed up in the statement that the closest investigation for every kind of an appropriation is necessary before the appropriation is made, and, thereafter, whenever a change is requested, of course, to require departments to show adequate reasons for modifying appropriations may seem to be needless red tape, especially in minor changes such as substituting a laborer for a coal-passer. Before that change is permitted, an investigation is made, and the need for it is determined. That is due largely to the fact that there may be some ulterior motive behind the change, which the investigation usually brings to the surface. So far as the change of a clerk from $1 200 to $900 is concerned, that is desirable in some instances. A department head may want to replace the $1 200 vacancy with a $900 position; on the other hand, he may want to replace that $1 200 clerk by a $1 800, and to eliminate a $600, position. These facts should be brought out through a careful examination.

So far as Mr. Brush's criticism with respect to supply estimates is concerned, I have endeavored to set forth in my paper the fact that consumption is the only basis on which the estimate for supplies can be based—the consumption of previous years is the only proper basis upon which to predicate appropriations for current

operation, and the forms require that the consumption be shown. Of course, detail estimates are desirable—how many screws, how many feet of lumber, etc.—but that detail is required as an indication whether or not definite plans have been made for the next year, or whether the estimate is the "best guess."

JOHN T. FETHERSTON, M. M. E. N. Y.—It is usually interesting and gratifying to be able to discuss the appropriation of a few hundred million dollars for the annual maintenance of New York City's numerous and varied activities. The extent and complexity of the budget-making task may be roughly appraised when it is considered that the annual tax levy of the City is about one-fifth the total amount expended yearly for the entire government of the United States, including military and civilian branches.

Mr. Lindars' excellent presentation of the subject with his clear conception of the present method of securing centralized financial control over appropriations and expenditures, should have special interest for the Municipal Engineers—workers in the ranks—particularly this evening when the all-absorbing problem of salary standardization is under discussion. Apparently, the principle underlying the budget, *i. e.*, highly centralized financial control, is to be further strengthened by centralized and standardized salary control.

Is this principle of centralized financial control sound? Does it provide a firm foundation on which to build a structure for efficient social service?

A municipal corporation is organized and maintained to serve community needs. Practically all city functions are performed at cost, hence profits, the standard of success in private business, are lacking. A high or low tax rate provides no index of economy unless the services rendered in either case are known and comparable. Thus, without a definite relation between expenditures, product and market values, no real conception of efficiency in municipal operations as a whole is possible at the present time. In detail, however, many municipal functions produce measurable products, and herein lies a feasible opportunity for setting up practical ideals as a substitute for the incentives of private business. "The Budget" should represent a practical ideal of municipal service. By or through "The Budget" every individual in the service of the community should be provided with equipment, a target to aim at, records of results and measures of efficiency—the relation of actual accomplishment to possible attainment. If the policy of the municipality as reflected in the form and substance of its annual appropriations provides no service ideals for officials and employees, it is bound to produce inefficiency.

The segregated form of budget sets up only an ideal of expenditure, and nowhere recognizes the positive elements of work, service and results—the main reasons for its existence. As a consequence, there is no incentive for economy; in fact, a saving in expenditure may result in a penalty instead of a reward. This unusual situation, no doubt, has resulted from unsatisfactory experience with the older form of lump-sum budget, in which no centralized control over work or expenditures existed, and short of public scandal, dishonesty, incompetency, or both, could flourish undisturbed. The segregated budget apparently was designed to curtail the opportunities of maladministration by department heads through close definition and restriction of the objects of expenditure without in any way providing a test of competency, the lack of which inevitably will result in greater loss to the municipality than through dishonesty.

Tested from a departmental standpoint by the twelve principles of efficiency promulgated by Mr. Harrington Emerson, one of our foremost industrial engineers, the segregated budget, in form, substance, and effect, lacks (1st principle) ideals; discounts (2) common sense and judgment; restricts ability to secure (3) competent counsel; has no effect upon (4) discipline; prevents the (5) fair deal, and nullifies any basis for (6) the efficiency reward. It secures no (7) immediate, reliable and accurate records of performance; has no bearing upon (8) work planning and dispatching; creates no (9) work standards; disregards (10) standardized conditions and (11) standardized operations, and provides no need for (12) written practice instructions. As a municipal plan of operations, the segregated budget must be considered negative in principle, restrictive in design, autocratic in operation, and opposed to every element of efficiency.

But destructive criticism is not helpful unless a remedy is available. Fortunately, for many municipal functions, particularly those under the head of public works, the remedy is well known to engineers whose duties are mainly concerned with constructive budgets—for plans, estimates, specifications, and contracts are nothing more than budgets. Apply the contract idea to departments engaged in measurable productive work by determining the physical elements of the problem (foundations of the structure), draft the plans, outline the specifications, estimate the cost, provide the required appropriation, sign the contract, and hold the contractor (department head) responsible for results. Inspect the work in progress, audit the physical product as well as the financial expenditure, and then it will be possible to secure the necessary control of activities, while recognizing every element of efficiency, not feasible under the present segregated budget system.

The so-called "Cost Data Budget" offers a solution of budgetary problems which has proved successful in constructive public work, and there is no reason why it should not be equally satisfactory in municipal maintenance work.

Systems and methods, in the final analysis, however, are only aids to efficiency, and the greatest problem in municipal affairs is to secure and retain competent administrators, executives and employees.

In this respect, the affirmative and progressive policy of the "Cost Data Budget" offers the greatest opportunity for municipal betterment, while the negative and restrictive principles of the "Segregated Budget," promoting indifference and stagnation, provide no hope of consistent advancement in the management of municipal functions.

Mr. Brush.—I want to correct an impression which apparently I made—that the supply budget was not to be based upon consumption of material. I did not intend to give that impression, because we all agree that a supply budget should be based upon consumption of material; but I think most of the engineers would agree that it is not desirable to attempt to guess at the units of material for the following year, when you have the actual figures of consumption for the past year to guide you in determining the approximate amount required for supplies. The feature I was criticising was the necessity, as called for by the Board of Estimate, of each department spending the time of guessing how much they would require of each particular supply, in detail, instead of determining on the basis of expenditure, or, rather, of material consumed, which is an actual amount that can be verified.

I also want to call the attention of Mr. Lindars to the impracticability of doing emergency work on temporary time; and, to illustrate, in the Borough of Richmond, the Department of Water Supply was allowed temporary time for laborer to take the place of men during their vacation—two weeks' vacation period. The money was allowed in the middle of July, and, up to date, out of seven men to be used for that purpose, one has been obtained, after exhausting sixty names that had been certified from time to time by the Civil Service Commission for appointment. If a main had broken last July, and we tried to get seven men, and we still had but one man, I think citizens would justly complain of lack of efficiency. I do not want to be understood as criticising the policy of temporary time, but simply to show the actual difficulty in getting men promptly, even if you have the money, under the present rules, which are probably made for the proper conduct of the City's business in employing men for its work. But, actually, you cannot get the men on temporary time in a hurry.

MR. LINDARS.—I hardly think the mere fact that you have not been able to get men for which money is provided for is in any way the fault of the segregated budget, but is that of the Civil Service Commission.

In respect of supplies, it seems to me that carefully laid plans of the engineering force should show what amount of material would be required next year. The fact that they have used 10 000 ft. of lumber last year does not mean they will require 10 000 ft. next year. That is the reason the details are required on the estimate sheets as well as the units of the past year.

MR. FLINN.—Before dismissing this subject, I would like to say one word more. It seems to me that any such device as a budget is intended as an instrument of economy, and, when carried into such detail, or extended to such small expenditures that it costs more to correct than to neglect, it ceases to be economical. I would like to call attention to an article in September's number of *Atlantic Monthly,* in which the writer points out that we are seeking to conserve labor and material resources, but overlooking and neglecting to conserve authority. We are using our highest officials to do trivial things. Let us think of that. If the Municipal Engineers be asked to offer some suggestions on this line, let us hope that this question will come to us early enough to give it mature deliberation.

MR. LINDARS (by letter).—Mr. Fetherston is evidently misinformed concerning the purpose and effect of a segregated budget. He states that nowhere does it recognize positive elements of work, service and results. On the contrary, the budget is based upon these elements. The various activities are resolved, first by the budget-makers, into three important elements; for example, a study is made in the highways bureau of a certain department. This study develops the fact that certain streets are in a bad condition. The area of pavement to be repaired is calculated as closely as possible, and the quantities of material required therefor determined. This work results in furnishing the Budget Committee the information that a certain quantity of asphalt, a certain quantity of broken stone and a certain quantity of sand will be required to make the necessary repairs. The Budget Committee learns further that tools are necessary to do the work. It finds, for instance, that an additional steam roller is necessary and that before the work can be done a concrete mixer must be purchased. The work to be done is resolved into units. Past results have determined that a man can average so many units of work of a given kind in a day. As the Budget Committee knows the number of units of work to be done it is an easy matter to determine the number of men or the number of days' work necessary to perform

the task. The next thing to ascertain is the cost of salaries and wages and the probable prices of the supplies, equipment and materials needed. When these various facts have been determined as accurately as possible, the Budget Committee is in a position to recommend appropriations for the year's work.

In making the budget in this way the Committee takes into account the quantity and nature of the work to be performed, the price of equipment, materials and supplies, the price of personal service and the number of workers necessary and then makes its appropriations for certain definite purposes and for the attainment of certain definite results.

Mr. Fetherston states that there is no incentive for economy in the present budget; and that, in fact, a saving in expenditure may result in a penalty instead of a reward. Apparently Mr. Fetherston is not acquainted with all the reasons that govern budget appropriations. I happen to know that in a number of instances the Board of Estimate has withheld appropriations from departments for the sole reason that the members of the Board did not believe that the department was capable of getting effective results from the appropriation, because in the past the department concerned had expended funds wastefully and with bad results. On the other hand, I have known of departments which have secured surprisingly large appropriations because previous appropriations had been handled with careful regard for economy and for results. Budget appropriations are not based, as Mr. Fetherston seems to assume, upon last year's expenditures. The last year's expenditures are taken as an experience basis but the real basis of the appropriation is the need for work to be performed next year.

Mr. Fetherston has applied Mr. Emerson's twelve principles of efficiency as a test and has found the segregated budget wanting. He states that the segregated budget lacks the first principle of ideals. The contrary is true. The segregated budget is the result of very clear ideals and what I regard as very high ideals.

Mr. Fetherston says that the segregated budget discounts common sense and judgment. In my opinion it was not until common sense and judgment was applied to budget-making that the segregated budget developed and we got away from the old scandals of a lump sum budget.

Mr. Fetherston says that the segregated budget restricts abilities to secure competent counsel. I think that a single glance through the budget will prove that he is wrong. The budget makes specific appropriations for high priced departmental engineers, consulting engineers, legal counsel and for expert counsel. In fact, the segregated budget has done so much to insure the employment of competent counsel that I am astonished at Mr. Fetherston's state-

ment. Before we had a segregated budget money which was intended for competent counsel was used to pay salaries to ward-heelers and political hirelings. Now the segregated budget compels the employment of competent counsel by making an appropriation for such counsel wherever needed and this appropriation must be used for that purpose if used at all.

Mr. Fetherston says that the segregated budget has no effect upon discipline. I think that if any of you will compare the present conditions in city departments with the conditions of a few years ago you will agree with me that there is a much finer, stricter discipline now, than before the segregated budget was adopted.

Mr. Fetherston says that the segregated budget prevents the fair deal. I am sorry to hear this statement from a man who must remember conditions a few years ago when a city employee had no guarantee of a fair deal. With lump sum appropriations department heads followed their own whims and prejudices and if they did not like employees who did not vote their way they could and did disregard all principles of a fair deal and made very unfair reductions of salary. The segregated budget has done more than anything else to stop this practice and to guarantee a fair deal. Under a segregated budget a man is not likely to deal unfairly with an employee when he knows that his act is to be passed upon at an open meeting of the Board of Estimate and Apportionment.

Mr. Fetherston says that the segregated budget nullifies any basis for an efficiency reward. This is a mere assertion. There is nothing in the world to support it, but there is support for the statement that the segregated budget gives a splendid basis for an efficiency award. Under the segregated budget the Board of Estimate and Apportionment knows what work is done by every man and is able to judge of individual merit and to give reward to those who are efficient. This, of course, was impossible in the days of a lump sum budget when the various positions and individuals were not and could not be considered by the Board.

Mr. Fetherston says that the segregated budget does not secure immediate, reliable and accurate records of performance. I admit that this statement is largely true but at the same time I assert that Mr. Fetherston cannot deny that the segregated budget has resulted in budget accounting which does give records of performance much more accurately and with much more reliable data than we ever had through any other agency.

Mr. Fetherston says that the segregated budget has no bearing upon work planning and dispatching. How he can say this I cannot understand, because the appropriations are based upon work

plans and consequently a dispatching of such work plans must be effected by the budget.

Mr.. Fetherston says that a segregated budget creates no work standards. I disagree with him. The appropriations are based upon fairly definite standards of work. For instance, in making appropriations for elevator inspectors in the Bureau of Public Buildings and Offices, studies are made to determine the number of inspections that a man should make under ordinary conditions in a day. A standard is set up and is applied to the appropriations. This system is followed wherever possible.

Mr. Fetherston states that a segregated budget disregards standardized conditions. He must know that a segregated budget has resulted in a movement now under way to standardize everything affecting the city government. As a result of revelations growing out of the preparation of the segregated budget, salaries and wages are now being standardized. Supplies and materials; forms of contract; plans and specifications; methods of accounting; methods of testing supplies and materials purchased by the city are being standardized and in fact, effort is being made to standardize everything to which a standard can be applied.

Mr. Fetherston states that a segregated budget disregards standard operations. What I have just stated in regard to standard conditions applies here. I may say further that the only standard operations now successfully maintained by the city are due almost entirely to the segregated budget.

Mr. Fetherston states that a segregated budget provides no need for written practice instructions. He might as well pertinently have said that it fails to quote Verse 13 from the Third Chapter of Luke. If his statement is true it is a credit to the segregated budget. I will admit that with such a budget written practice instructions are not so necessary as they would be with an unsegregated budget, consequently a segregated form of budget is for that reason better than a lump sum form.

Mr. Fetherston goes on to suggest as a remedy that we draft the plans, outline the specifications, estimate the cost and provide the required appropriations. That is exactly what we are doing in the segregated budget and it is exactly what Mr. Fetherston is proposing that we do away with.

Mr. Fetherston asserts that the so-called cost data budget offers a solution of budgetary problems which has proved successful in constructive public work. He must know that the appropriations for constructive public work are much more restricted by the Board of Estimate rules than the appropriations made for maintenance work. Under the segregated budget a department head buys his

supplies and materials upon plans and specifications which do not require the approval of the Board of Estimate and Apportionment but under the Corporate Stock Budget rules, appropriations for constructive work cannot be spent so freely by a department head. In fact, the department head is required to go to the Board of Estimate in almost every important step connected with construction work.

All that is necessary to refute Mr. Fetherston's concluding statement that "the negative and restrictive principles of the segregated budget have promoted indifference and stagnation" is to make a comparison between the average city department of to-day and the same department of six years ago when there was really stagnation and absolute indifference to every principle of efficient service.

THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.

Paper No. 75.
PRESENTED OCTOBER 26, 1912.

THE FOURTH AVENUE SUBWAY, BROOKLYN.

BY HENRY L. OESTREICH, M. M. E. N. Y.*

WITH DISCUSSION BY
F. H. MELLERT, E. G. HAINES, S. M. PURDY, JOSEPH HUNT
AND H. L. OESTREICH.

The Fourth Avenue Subway is a four-track structure beginning at the Brooklyn end of the Manhattan Bridge and extending southerly along Flatbush Avenue Extension, Fulton Street, Ashland Place and Fourth Avenue from Atlantic Avenue to Forty-third Street.

On June 27th, 1907, the Board of Rapid Transit Commission approved the plans and specifications prepared by Chief Engineer George S. Rice, adopted the form of contract for "construction only" and set the date for a hearing for the last Thursday in July, 1907.

On July 1st, 1907, the Public Service Commission succeeded to the powers and duties of the Board of Rapid Transit Railroad Commission.

On July 30th, 1907, a public hearing was held and on October 2d, 1907, the Public Service Commission, by a vote of 3 to 2, passed a resolution to the effect that bids should be asked for the construction of the Fourth Avenue Subway.

A number of public hearings were held, after which the specifications and plans as revised by Henry B. Seaman, Chief Engineer, were adopted.

* Senior Assistant Division Engineer, Public Service Commission.

Bids were opened for all six sections on May 8th, 1908, and contracts were awarded on May 22d, 1908, for all sections except the contracts known as M. B. Ex.-1, the latter being awarded May 25th, 1908. The time for completion of each contract was 24 months.

By an injunction dated June 12th, 1908, the board of Estimate and Apportionment was restrained from giving its approval pending the determination of the status of the City's borrowing capacity under the constitutional debt limit. The injunction was vacated on October 26th, 1909. The contracts were approved by the Board of Estimate and Apportionment on October 29th, 1909. The contracts were executed and the contractors' bonds were filed on November 9th, 1909.

Table 1 is a description of the contracts briefly abstracted from the records of the Public Service Commission.

These contracts cover four miles of subway and include six local and two express stations (Plate 67). In general, the subway has four tracks, but between Willoughby Street and Fulton Street, there are six tracks, two of the tracks passing westward into Willoughby Street without grade-crossing. The six tracks continue southward on the same level through De Kalb Avenue Station and into Fulton Street where the two outer tracks continue on a descending grade and the two inner tracks bifurcate so as to form a double-deck structure of eight tracks on Fulton Street near Ashland Place. The upper four tracks are eventually to continue eastward along Fulton Street; the lower four tracks extend along Ashland Place, passing under the Interborough Subway Station at Flatbush Avenue and continuing as a four-track structure along Fourth Avenue to Forty-third Street. South of the Thirty-sixth Street Station, four tracks continue southward toward Forth Hamilton, while one branches eastward from the upper level and three tracks descend in such a manner as to pass under the Fort Hamilton tracks, thus forming the beginning of the Rapid Transit Line to Coney Island.

The typical section of the tunnel is shown in Plate 68. The tracks are 14 ft. center to center and the distance from the base of rail to the roof is 15 ft. The contract required the tunnel to be water-tight, but the specifications did not require water-proofing on roofs or sides except at such points where the Subway passes

TABLE 1.

	MB- Ex- 1.	9—C- 1.	11- E -A -1.	11- A—2.	11 A 3.	11—A -4.
Contract price for tunnel	$1 050 984	$3 486 019	$3 393 091	$2 225 078	$1 945 640	$2 757 457
The above was made up as follows:						
Station finish	77 886	188 844	91 608	196 146	196 148	84 500
Underpinning buildings	....	100 000	145 504	15 120	....	45 280
Sewers	81 002	23 023	118 599	180 443	178 621	43 414
Surface and elevated railway support	9 524	41 814	7 046	....	....	....
Pipes and ducts in streets	7 476	29 686	28 504	87 959	57 848	89 069
Net construction	925 596	3 108 152	3 000 880	1 915 410	1 588 523	2 545 194
Length of structure	2 514	2 088	3 747	3 587	4 799	4 087
Contract price, per linear foot	$418	$1 646	$906	$620	$407	$688
Net construction, per linear foot	368	1 489	801	534	332	680
Lineal feet, single track	11 648	18 305	14 968	14 348	19 116	16 618
Net construction, per linear foot of track	$79	$234	$200	$133	$98	$153
Pipe galleries; separate contract; abandoned after having begun work	$101 874	$58 095	$208 185	201 672	$251 076	$178 665

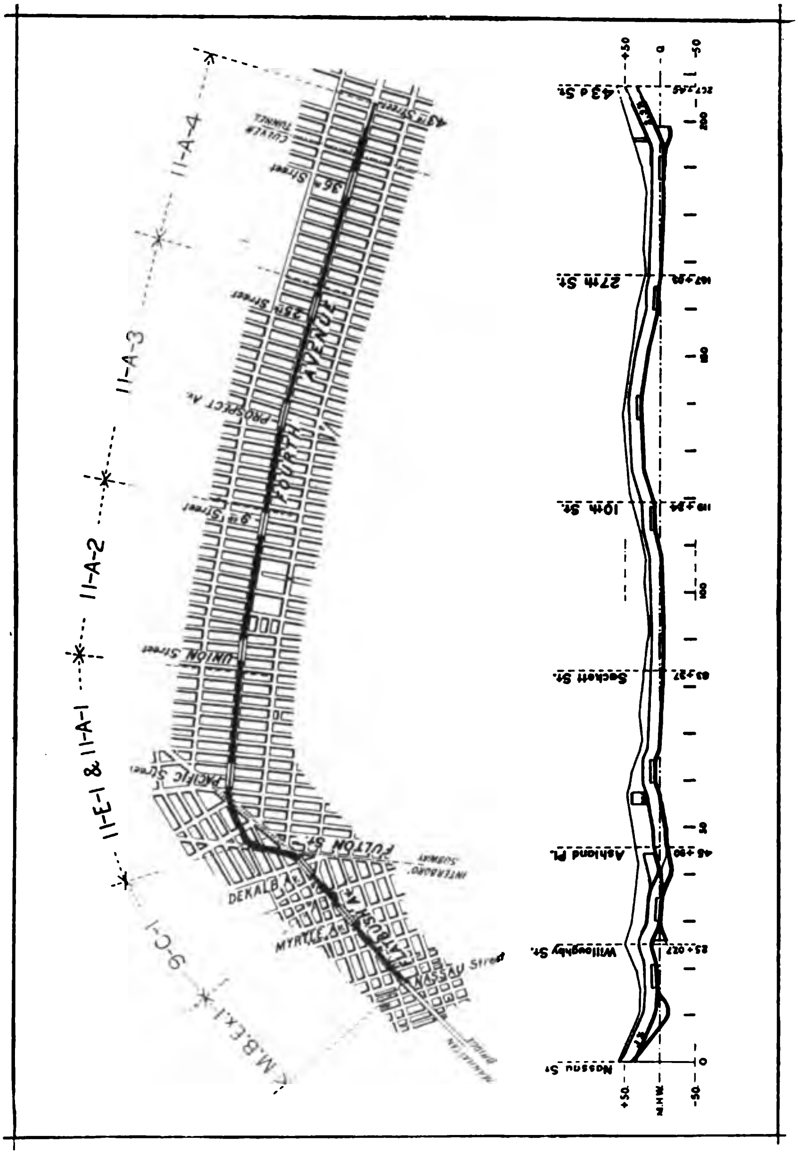


PLATE 67.—PLAN AND PROFILE—SUBDIVISION INTO CONTRACTS.

below Elevation 103. The roof and sides of all stations were waterproofed.

Resting on the floor and against the side-walls are two rows of four-way ducts, 5 high, making a total of 40 holes on each side of the tunnel. These are encased in 4 to 8 in. of protection concrete—the top of the 21-in. bench so formed being 4 ft. above base of rail and at the same level as the platform of the train. Fastened to the wall, 3 ft. above the duct-bench, is 1½-in. iron-pipe hand-rail. Duct manholes or splicing-chambers are located at the ends of the station platforms and at intervals of 500 ft. throughout the tunnel.

The contracts were known as M. B. Ex.-1, 9-C-1, 11-E-A-1, 11-A-2, 11-A-3 and 11-A-4.

The six sections were let to four different contractors at an aggregate price of $15 801 836.

Under these contracts, no ties or rails were placed but the interior finish of all stations, such as Keene Cement ceiling, white glazed and ceramic tile on the walls, was placed complete. Newsstands, porters' closets and toilet-rooms were provided in each station; the latter were so located as to drain to the sewers, except at Pacific Street, Union Street and Prospect Avenue, where the sewers are considerably higher than the floors of the stations. At these points, a sump is provided which will later be drained by an automatic ejector operated by air power.

SECTION M. B. EX.-1.

Flatbush Avenue Extension, Between Nassau and Willoughby Streets.

Smith, Scott & Co., Contractors.

The contract was awarded to J. P. Graham, by whom it was assigned to Smith, Scott & Co. To provide for certain improvements in plan, a modified agreement was made, increasing the original contract price of $1 121 851 to $1 152 308, the price for the pipe galleries $101 374, being included in each case.

Through Gold Street Station, the structure is four tracks wide, but to facilitate cross-overs without grade-crossings, a fifth track, depressed, is added for the northerly 1 300 ft. of the contract. Near the southerly end of the contract, the structure widens out to a total width of about 75 ft. (Plate 69, Fig. 1).

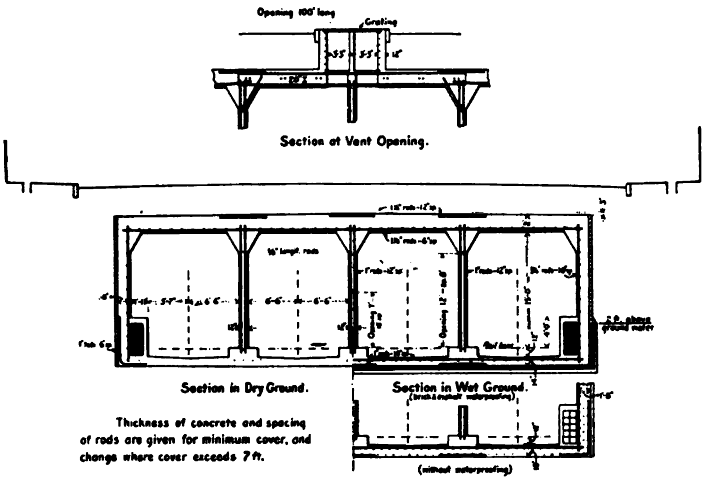


PLATE 68.—TYPICAL SECTIONS.—WATERPROOFING BY MEANS OF BRICK IN MASTIC AND BY MEANS OF SPECIALLY REINFORCED CONCRETE.

The structure is both steel-beam and reinforced concrete construction.

From December 20th, 1909, to Spring, 1910, the plant was assembled and the temporary tramway was placed from the work to a dock under Manhattan Bridge. March 18th, 1910, the actual work of excavation was begun between Myrtle Avenue and Bridge Street. The excavation varied from 25 ft. to 40 ft. in depth, the upper portion of it was composed of sand and clay and the lower portion consisted of sand, gravel and some boulders. Ground-water was not encountered above Elevation 95 (5 ft. below mean high water). Therefore, all work was above water except part of the depressed track. The excavation was made by means of a large Lidgerwood drag-line excavator, supplemented by three electrically driven derricks and a locomotive crane. The loaded side-dump cars were drawn by 20-ton locomotives over a temporary track from the work to a dock under the Manhattan Bridge, where the material was dumped into scows and taken for final disposal to the Plank Road Improvement, Newark Bay.

Flatbush Avenue Extension had never been opened to traffic and the specifications permitted the contractor to prosecute his work in open cut, requiring him to place bridges only at cross-streets. The sides of the trench stood up well and only the lower portion of the cut was sheeted.

Concrete was mixed by a rotary mixer at a central mixing plant at the east side of the work, near Johnson Street, on a piece of property leased by the contractor.

The concrete was hauled in trains of four metal bottom-dump cars to the place required and was delivered to the forms through chutes. All concrete was mixed in the proportion of one of cement, two and a half of sand and four and a half of gravel. The forms used were wooden except for reinforced concrete where collapsible steel forms were used for the walls. The roofs varied in width and the space had to be filled by wooden forms supported by angles at the top of the steel side-forms. There were two sets of steel forms for four tracks 20 ft. in length.

Brick in mastic was used for the water-proofing of the roof of Gold Street Station, and for the depressed track below a line 3 ft. above mean high water (Elevation 103). The side-walls of

PLATE 69.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
OESTREICH ON THE FOURTH
AVENUE SUBWAY, BROOKLYN.

FIG. 1.—LOOKING SOUTH AT COMPLETED SECTION OF TUNNEL AND DEPRESSED FIFTH TRACK; STEEL SIDE-FORMS;—CONSTRUCTION TRACK AND DINKEY ENGINE.

FIG. 2.—LOOKING NORTH, SECTION OF DEKALB AVENUE STATION: UNDERPINNING OF VAULTS; GRILLAGES FOR COLUMN; FIVE OF THE SIX TRACKS COMPLETED.

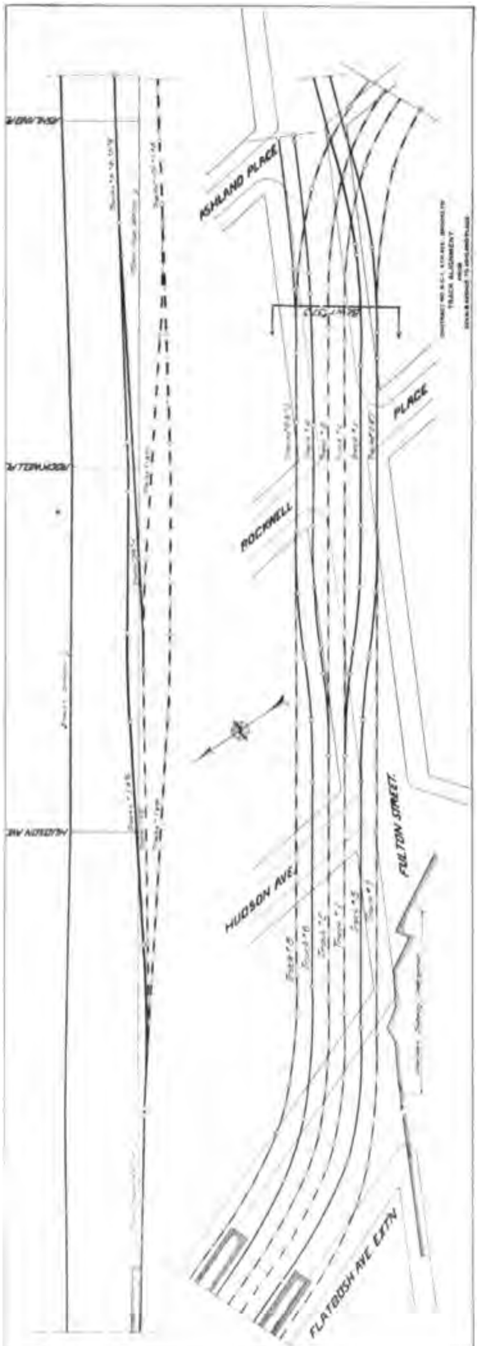


PLATE 70.—DIAGRAM OF TRACKS ON FULTON STREET.

Gold Street Station from subgrade to roof were waterproofed with 3 ply of woven fabric and pitch.

Six columns of the Myrtle Avenue Elevated Road were supported and later four of them provided with new foundations on the roof of Gold Street Station, and the foundations of two of them were carried to the subgrade of the mezzanine platform (Plate 71, Fig. 1).

The total quantities for this contract were 202 000 cu. yd. of excavation, 42 700 cu. yd. of concrete, 1 750 tons of structural steel and 1 910 tons of steel rods. The daily average number of men employed was 300.

Mr. P. E. Hickey was the managing partner for the contractor and Mr. W. H. McDonald was the Engineer. Mr. H. Coyne was Section Engineer for the Public Service Commission.

SECTION 9-C-1.

From Willoughby Street Along Flatbush Avenue Extension and Fulton Street to Ashland Place.—William Bradley, Contractor.

This is a six-track structure becoming a double-decked eight-track structure on Fulton Street at Ashland Place (Plate 72). From De Kalb Avenue Station northward there are also two depressed tracks curving westward into Willoughby Street.

The contractor began work November 16th, 1909. The excavation was sand and loam, the lower strata being, to a considerable extent, good building sand. The contractor was fortunate in finding ground-water at Elevation 95 instead of Elevation 101 as had been expected. For about two months a small steam-shovel was used in Flatbush Avenue Extension. After this was abandoned, three pairs of cable-ways were used. From Willoughby Street to Fleet Street the trench was sheeted and braced in the usual manner, principally because of the presence of water in the depressed track. From Fleet Street to Fulton Street only the lower portion of the trench was sheeted and braced. At De Kalb Avenue Station the structure is 125 ft. wide. The cut in Flatbush Avenue Extension was 35 ft. deep, the base being about 90 ft. wide, the top having a width of about 120 ft. Practically no bracing was used. This was due to subgrade being above ground-water (Elevation 95),

PLATE 71.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW Y RK.
OESTREICH ON THE FOURTH
AVENUE SUBWAY, BROOKLYN.

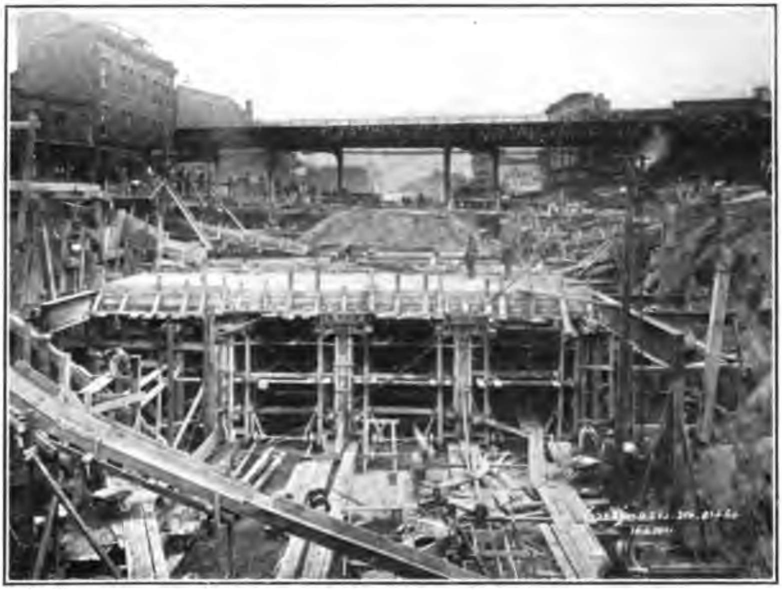


FIG. 1.—LOOKING NORTH, SHOWING TUNNEL SECTION IN GOLD STREET STATION AND MYRTLE AVENUE ELEVATED R. R.—CHUTES FOR DELIVERING CONCRETE.

FIG. 2.—FULTON STREET, ASHLAND PLACE TO HUDSON AVENUE. METHOD OF UNDERPINNING ELEVATED RAILROAD.

and the bank being of material that would stand up nearly vertical. With the exception of parts of the De Kalb Avenue Station all the work was of steel-beam construction (Plate 69, Fig. 2).

Preceding the excavation, the buildings were underpinned on the south side of Fulton Street from Hudson Avenue to Rockwell Place and on the north side of Fulton Street from Rockwell Place to Ashland Place. The Crescent Theatre, which overhangs the Subway a few feet, was also underpinned. All told, there were about 22 buildings underpinned to an average depth of 40 ft. below the street surface. The method employed in underpinning buildings was to temporarily support the piers on pairs of I-beams parallel with the building, excavate a pit by means of box-sheeting to ground-water and then by means of interlocking steel sheeting through 6 to 10 ft. of water to a short distance below subgrade of the tunnel. The steel sheeting was 6 in. wide, 12½ lb. per foot and driven by means of a steam-hammer using compressed air. The excavation thus made was filled with concrete and the load taken off the temporary I-beams, in the usual manner, by means of thin iron wedges driven between wedge-stones.

The work was always done on alternate piers. The amount of settlement due to this work was very small and no damage was done to the buildings.

At Flatbush Avenue and Fulton Street, the elevated road rests upon the Interborough Subway (Plate 70). The excavation having to pass close to, and from 18 ft. to 25 ft. below the bottom of the old Subway, it was necessary to underpin the same. This was done by placing pairs of 24-ft. I-beams under the side-wall of the old tunnel and sinking piers under these to a foot below subgrade of the new tunnel.

While the different underpinning pits varied in size, they were generally 8 ft. long and 6 ft. to 8 ft. wide. The excavated material was cast up by the men on platforms to the surface. Upon completion of the excavation these platforms were removed, leaving the pit free from interior bracing. This permitted the filling of the pit with concrete and occasionally dropping into it large stones without danger to the sheeting, which would not have been the case had cross-bracing been used.

On Fulton Street, the columns of the elevated road had to be

temporarily supported and most of them provided with new foundation piers on the roof of the tunnel. The method of doing this is shown in Plate No. 71, Fig. 2. A pair of 48-in. plate-girders, 60 ft. long, spaced 5 ft. apart, was placed in the roadway near the curb in Fulton Street. On top of this, and opposite the elevated column, was placed a wooden tower made up of two bents of two 12-in. by 12-in. verticals and two batter posts, crossed-braced by means of 3 by 10-in. plank. The sills and caps were of 12 by 12-in. timber. These towers were from 20 to 35 ft. in height. Blocking was placed on the caps until it touched the bottom of the transverse truss of the elevated structure. Steel wedges were then driven between the pier and the base-casting of the column until it had been raised sufficiently to allow the placing of an additional 2-in. plank at the top of the wooden tower. When the wedges (and later the pier) were removed, the elevated structure including the column was supported by the wooden tower. A few feet from the ends of the 48-in. girders upon which the towers rested, pits were sunk to a foot below subgrade and in these timber horseheads were built for the support of the girders. Below the sills of the horseheads was a platform of two closely-placed floors of 3-in. planking at right angles to one another, upon which rested a number of 12-in. by 12-in. timbers at right angles to the horsehead. There were 39 elevated columns supported in this manner.

On Fulton Street the trench for the tunnel was sheeted from the surface to ground-water, and 12-in. by 12-in. cross-bracing was spaced about 10 ft. so as to avoid interference with the steel bents of the structure. The lower tier of sheeting along parts of Fulton Street was of interlocking-steel, driven to about 4 ft. below subgrade, and in other places it was 3-in. tongued and grooved yellow pine, 16 ft. long, driven 7 ft. below subgrade.

The street was decked from house-line to house-line, the trolley tracks being carried on the timbers of the cut. The commencement of work on Fulton Street was delayed on account of the need of acquiring easements on private property through which the Subway passes. On the north side of Fulton Street, from Flatbush Avenue to Rockwell Place and on the south side of Fulton Street from Rockwell Place to Ashland Place, the buildings were not removed until about a year after the contractor began work. The

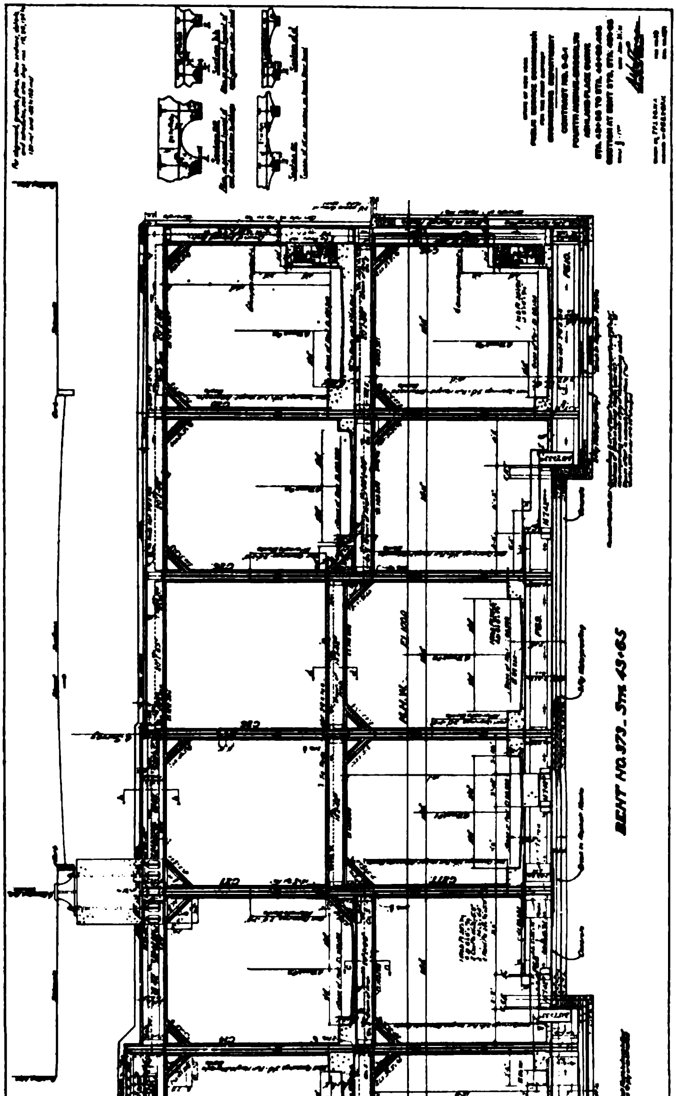


PLATE 72.—EIGHT-TRACK STRUCTURE ON FULTON STREET, NEAR ASHLAND PLACE.

contractor used derricks for his excavation, and teams hauled the material to dumps at the foot of Hudson Avenue, and the Gowanus Canal at Third Street and Sixth Street. The average amount of excavation for a month was about 9 000 cu. yd., the quantity being considerably less while the work in Fulton Street was in progress.

Two to three sumps were placed in each block along Fulton Street and electrically driven pumps with 6-in. discharge and a capacity of 500 gal. a minute, were kept working almost continually in order to temporarily lower the ground water (Plate 73, Fig. 1).

For a short time, concrete was mixed by means of a rotary mixer located in Flatbush Avenue Extension near Fleet Street. This was operated by a 25-h.p., 220-volt motor. It was used for the concrete in the floor and walls of De Kalb Avenue Station. The concrete dropped directly from the mixer into small cars operated on 2-ft. gauge tracks from which they were dumped into the side-wall forms without the use of a chute. This concrete was of very good quality. The contractor, however, soon abandoned this method and erected a gravity mixer which was located for a while at Fleet Street, then at Pacific Street and later in Ashland Place, just south of Fulton Street.

A batch of concrete consisted of a four-bag mixture in the proportion of one of cement, two and a half of sand and four and a half of gravel or broken stone.

The central gravity mixer was composed of four steel hoppers of 15 cu. ft. capacity, all at the same level. Below this and under one another, there were three mixing pans, each of 28 cu. ft. capacity. The proper amount of sand was placed into each of the four upper hoppers, then the cement, then the stone. The water (3.6 cu. ft.) was then added, the materials were released through the bottom and fell into the first mixing-pan where their fall was checked. The bottom of this hopper was then opened and the partially mixed material fell into the second mixing-pan, where again its fall was checked. The same operation was repeated in its passage to the third pan. The concrete was then ready to be hauled to the work.

The distance from the bottom of the four loading pans to the bottom of the third or lowest mixing pan was 21 ft. while at Pacific Street, and 13 ft. while at Ashland Place. This method of mixing concrete is not as satisfactory as by means of rotary mixers. From

FIG. 1.—THREE PUMPS DISCHARGING INTO FLUME ON FULTON STREET, BETWEEN HUDSON AVENUE AND ROCKWELL PLACE.

FIG. 2.—LOWER "E"-"F" DRIFT FOR EAST WALL OF EAST TRACK UNDER THE ATLANTIC AVENUE STATION OF INTERBOROUGH SUBWAY.

the gravity mixer, the concrete was hauled in steel carts to the place of deposit in the work. In passing over the rough pavement, the stone and sand of the concrete would tend to settle, leaving from 2 to 3 in. of water, carrying some cement in suspension on top. This necessitated turning over the concrete by hand after it was dumped at the mixing board and before entering the chute.

The trouble was aggravated at times by long haul and when the contractor used broken stone instead of gravel.

The men found concrete made of broken stone difficult to work to a smooth surface, due to the angular character of the stone, while little difficulty was experienced in working concrete made of gravel in the forms and producing a good job.

Water-proofing on the sides of De Kalb Avenue Station consisted of six plys of woven fabric applied with pitch and 4 in. of brick in mastic. On the roof of the station were placed two layers of woven fabric and one row of brick in mastic which had 4 in. of protecting concrete over it. Wherever the rest of the structure lies below Elevation 103 there were placed on the bottom two ply of woven fabric and two layers of brick in mastic, making a thickness of 5 in.; on the sides there was placed an 8-in. wall of brick in mastic.

The total quantities on this contract were 337 000 cu. yd. of excavation, of which 75 000 cu. yd. were below mean high water, 59 700 cu. yd. of concrete, 10 500 tons of structural steel and 790 tons of steel rods. The contractor employed about 350 men.

The superintendent was Mr. Thomas Galligan. Mr. G. Rogers was the Engineer for the contractor from November, 1909, to September, 1911, after which time Mr. S. U. Hopkins held that office. During the same periods, Mr. A. E. Clark and Mr. P. Entenmann were the Section Engineers for the Public Service Commission.

11-E-A-1.

Ashland Place and Fourth Avenue From Fulton Street to Sackett Street.

Wm. Bradley, Contractor.

This is a four-track structure, and the portion on Fourth Avenue was changed from reinforced concrete construction to steel-beam construction at the request of the contractor. Actual work

of excavation was begun near De Graw Street on December 24th, 1909. The upper portion of the excavation was sand mixed with clay, while the lower portion was, for the most part, good building sand. There was considerable delay on the part of the City, in acquiring the necessary, temporary and permanent easement on private property under which this portion of the subway passes. The alignment was also changed by the city. The contractor used cableways and buckets, and the material was hauled away by teams—the greater part of it being dumped into scows at Gowanus Canal at Third Street and at Sixth Street. The contractor was fortunate in finding ground-water at Elevation 95 instead of Elevation 101 as was anticipated.

The contractor underpinned the buildings on the east side of Ashland Place including the Academy of Music; the latter work was done in a very satisfactory manner, without material settlement and without cracking the walls of the building. At Flatbush Avenue, the subway passes underneath the Atlantic Avenue Station operated by the Interborough Company. The contractor placed this work in the hands of Jacobs & Davies, Mr. James Forgie being the managing partner in this case. The work was done by force-account method; was begun September 11th, 1911, and completed the middle of March, 1912.

It was 235 ft. long between shafts and subgrade was about 50 ft. below the street surface (Plate 73A). The loads on the subway columns, which had to be supported, varied from 100 to 150 tons. This portion of the tunnel was built as four solid concrete arches with an alignment of non-concentric curves, thus making the walls between tracks vary from 2 ft. to 13 ft. in thickness. The method of construction was to drift in on the lines of the walls from subgrade of tunnel to 2 ft. below the springing line of the arch, using a heading about 15 ft. high and 11.5 ft. wide (Plate 73, Fig. 2).

The concrete for the wall was then placed. The next drift was made above the wall just built and in such a manner that the bottom of the old subway was supported on closely-spaced 15-in. I-beams running longitudinally with the new tunnel and blocked down directly onto the wall just built (Plate 75, Fig. 1). Cross-drifts known as "arch-drifts" were made from one wall to the other and the concrete was poured in the arch and spandrels over the

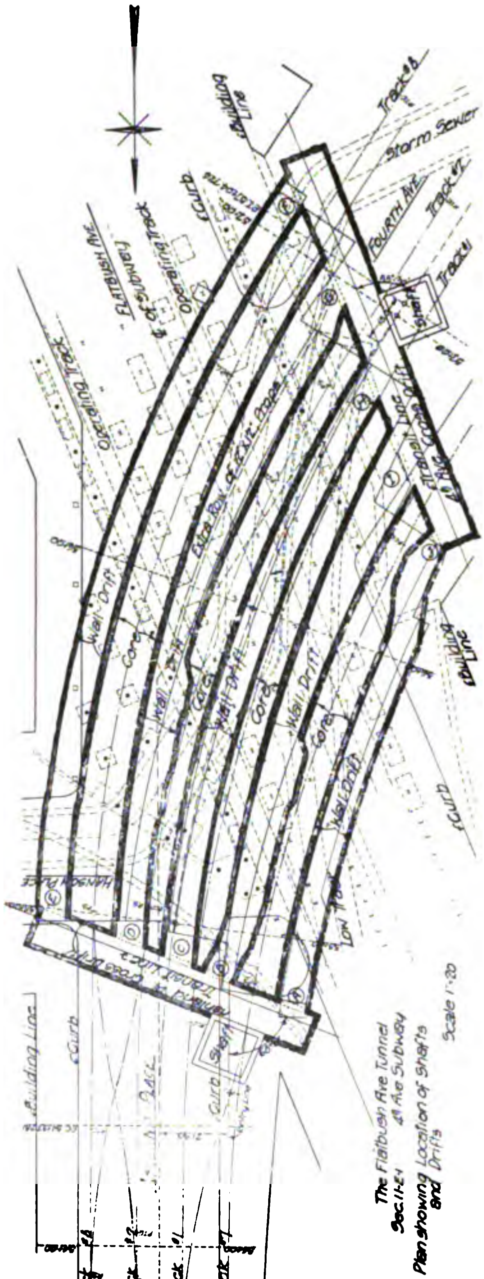

The Flatbush Ave Tunnel
Sec. 11-E1 4th Ave Subway
Plan showing Location of Shafts and Drifts
Scale 1":20'
Flatbush Ave.
Fourth Ave.
Storm Sewer
Operating Track
Wall Drift
Core
Shaft
Building Line
Curb
Hanson Place

PLATE 73A.

walls at the same time (Plate 75, Fig. 2). A rotary mixer was used for a part of this concrete. The section of arch placed over the walls was usually from 12 to 15 ft. in length. Grout-pipes which were placed at frequent intervals in this arch were later pumped full of 1 to 2 mixtures of either cement or Lias lime under pressure of 80 lb. per sq. in. (Plate 76, Fig. 1). After the arch had been poured, the core below it was excavated and the bottom concrete of the tunnel was placed. All this work was above ground-water, principally in sand. An old depressed track and a 15-ft. sewer, the concrete of which had to be removed by blasting, complicated the work considerably. At times, the exceedingly fine, dry sand flowed very freely, and was the cause of the accident which resulted in the death of two of the men. The work was carried on continuously by about 300 men in three 8-hour shifts, and while there was some settlement in the Atlantic Avenue Station, causing the cracking of some of the tile and Keene cement ceiling, it was no more than could be expected from operations under such difficult conditions.

Progress of excavation in the headings averaged 4 to 7 ft. of heading per day of 24 hours. During the week ending October 22d, 1911, when all five headings were being excavated, the progress was 154 ft. for the week.

The excavation along Fourth Avenue was carried on in a trench that was sheeted and braced transversely every 15 ft.

West of the center line of Fourth Avenue from Butler Street to Hanson Place, it was necessary to excavate the 15-ft. circular storm-sewer. During construction, part of the water was diverted into the South Portland Avenue sewer by means of a bulkhead and the remainder was taken care of by a flume on the east side of Fourth Avenue. Later, this discharged into the temporary storm-sewer which was built inside of the completed east track of the Fourth Avenue Subway, from Atlantic Avenue to Butler Street (Plate 74). At Bulter Street the sewer passes from east to west under the subway in a syphon composed of two reinforced concrete pipes 8 ft. 5 in. in diameter, with a 16-in. cast-iron, dry-weather flow.

No difficulty was experienced with the excavation for the tunnel except in the most southerly block where the work just enters the northerly end of the old Gowanus Swamp. Here they encountered

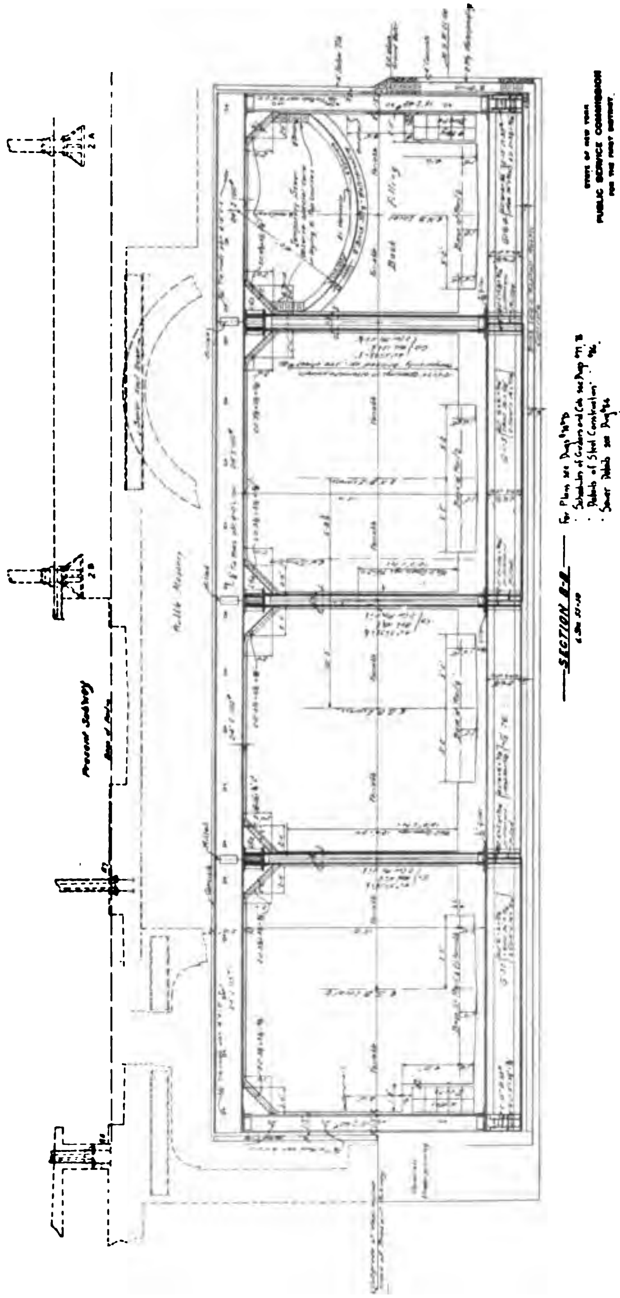


PLATE 71.—SECTION FROM ORIGINAL (STEEL BEAM) DESIGN FOR CROSSING UNDER ATLANTIC AVENUE STATION. NOTE TEMPORARY SEWER IN COMPLETED EAST TRACK OF NEW SUBWAY.

a black, water-soaked material. This made it difficult to keep sheeting from moving and caused some of the houses on the west side of Fourth Avenue to settle 2 to 3 inches. The contractor was required to make good all physical damage to buildings by the terms of his contract.

The concrete was mixed at the same gravity mixer which supplied Section 9-C-1, and was hauled to its place in the structure in steel carts. Brick in mastic was used to water-proof the bottom and the sides below Elevation 103.

The total quantities were 356 000 cu. yd. of excavation, of which 39 000 cu. yd. were below mean high water, 69 000 cu. yd. of concrete, 6 400 tons of structural steel and 2 000 tones of steel rods. The daily average number of men employed was about 300.

The Superintendent was Mr. Thomas Galligan. Mr. G. Rogers was the Engineer for the contractor from November, 1909, to September, 1911, after which time Mr. S. U. Hopkins held that office. During the same periods Mr. E. G. Haines and Mr. J. Connelly were the Section Engineers for the Public Service Commission.

SECTION 11-A-2.

Fourth Avenue, Between Sackett and Tenth Streets.

E. E. Smith Contracting Co., Contractors.

The two local stations, each 435 ft. long at Union Street and at Ninth Street, are of steel-beam construction with jack arches of concrete—the subway between stations being 4 tracks wide and of reinforced concrete construction. This is the section near "The Stone House at Gowanus," where it was hoped to find some relics of the Battle of Long Island.

The contractor began work of excavating at Carroll Street on January 5th, 1910. The contract required the placing of two temporary road-ways for maintenance of traffic. Ten electrically-driven, movable, stiff-leg derricks hoisted the material from the cut, and teams hauled it to scows at Sixth Street and Gowanus Canal. The amount of material handled per derrick per day varied from 75 to 100 cu. yd. Plate 77 shows the outline of the original Gowanus Swamp, transferred from a map dated 1776 to the map of South Brooklyn, showing the streets as now built. With the exception

FIG. 1.—AN ARCH DRIFT IN ATLANTIC AVENUE UNDERCROSSING, LOOKING EAST. THE 15-INCH I-BEAMS AT TOP OF PICTURE SUPPORT THE FLOOR OF INTERBOROUGH ATLANTIC AVENUE STATION.

FIG. 2.—IN ARCH DRIFT IN ATLANTIC AVENUE UNDERCROSSING LOOKING EAST. SHOWING CENTERS OVER EAST TRACK OF NEW SUBWAY. THE ENTIRE SPACE SHOWN IS TO BE FILLED WITH CONCRETE AND GROUTED.

of the portion between Seventh Street and Tenth Street, the excavation was in ground originally filled in over a salt marsh. The material was water-soaked so as to create a constant pressure against the sheeting. At one point Gowanus Canal is only 150 ft. to the west of the subway. Between Union Street Station and Sixth Street, the contractor excavated for the two westerly tracks in advance of the two easterly ones in the hope that the excavation thus made would tend to slowly drain the material under the east roadway. Nearly every rainstorm overtaxed the capacity of the existing sewers and filled the subway trench with water to a depth of 5 to 8 ft. These rainstorms caused some delay and tended to keep the material back of the sheeting in a water-soaked condition. Occasional pockets of very fine material were found which would boil up from under the sheeting. Another reason for not opening the full width of the excavation was the existence of a large sewer under the east roadway. During the winter of 1910 this sewer was rebuilt under the east sidewalk before making excavation for the two easterly tracks. When subgrade for the sewer was reached, the material was found to be very fine sand and loam containing so much water that a man could push an inch pipe down into it for several feet without any difficulty. Wooden piles, averaging 20 ft. in length, were driven from Sackett Street to Sixth Street except for a space of about 200 ft. This sewer discharged into an inverted syphon crossing Fourth Avenue under the subway at Seventh Street. The syphon consisted of two 6-ft. circular reinforced concrete tubes for the storm-flow, and one 30-in. vitrified pipe grade-crossing for the dry-weather flow.

From Seventh Street to Tenth Street, where the excavation was in sand and loam, the opening was made for the full width of the structure and no difficulty was encountered (Plate 78). The work in the two blocks from President Street to Sackett Street was left to the last because all the information obtainable indicated that the contractor would find nothing but very fine, water-soaked material. An additional reason was, that nearly every building in these two blocks was 10 to 14 in. out of plumb, and the Building Department had notified the owners that the buildings were unsafe.

In order to insure against slides from under the building while underpinning the large tenement at the southeast corner of Union

Street and Fourth Avenue, interlocking steel sheeting was driven between the building and the subway line. After this, the piers of the building were underpinned by means of 10-in. cylindrical steel piles driven in 5-ft. sections by means of a "goat" attached to a drop-hammer pile-driver (see Plate 76, Fig. 2). After being driven a few feet below the subgrade of the tunnel, the piles were filled with concrete and the piers for the houses built on top of them.

Fortunately, the material found while excavating these two blocks was not as bad as had been expected and there was no appreciable settlement of or damage to the houses.

Twelve-inch slabs of concrete without reinforcing rods formed the floor of the subway above ground-water and these slabs were not bonded to the column footings. The center and quarter walls were 12 in. thick and reinforced with 2 rows of 1-in. vertical rods, spaced 12 in. center to center and several longitudinal rods fastened to them by means of wire clips. The side walls had 1¼-in. bent rods in the lower outer corner, and vertical 1¼-in. rods, spaced 6 in. center to center, and placed 2 in. from the inner face of the wall (Plate 79, Fig. 2). The thickness of the side-wall varied from 20 in. to 22 in., depending upon the depth of the subway below the street level, the proximity to buildings and, in some cases, the hydrostatic pressure. In the case of ground water being less than 5 ft. above subgrade, a 12-in. slab with 1-in. reinforcing rods spaced 10 in. center to center was used for the floor. These rods extended from under the side wall to a point about 5 in. beyond the center line of the structure, where they overlapped those in the floor of the other half of the tunnel. Where the ground-water was more than 5 ft. above the subgrade, 1¼ in. rods spaced 6 in. center to center were used and the effective depth of concrete for the beam or slab varied from 14 to 24 in. For the roof, 1¼-in. rods spaced 6 in. center to center extended from the side wall to 5 in. past the center line in all cases, but the effective depth varied from 24 to 28 in., depending upon the amount of "cover" over the roof.

Portland cement, tested and tagged by the Public Service Commission at the mills, was brought to the work by rail and distributed along the job by means of teams. Cow Bay sand and washed gravel, the latter ranging in size from ¼ in. to 1¼ in., were

FIG. 1.—INTERIOR VIEW OF COMPLETED TUNNEL FOR ONE TRACK. THE GROUT PIPES SHOWN WERE PLACED BEFORE ARCH WAS CONSTRUCTED, AND EXTEND UPWARD TO WITHIN A FEW INCHES OF THE BOTTOM OF INTERBOROUGH SUBWAY.

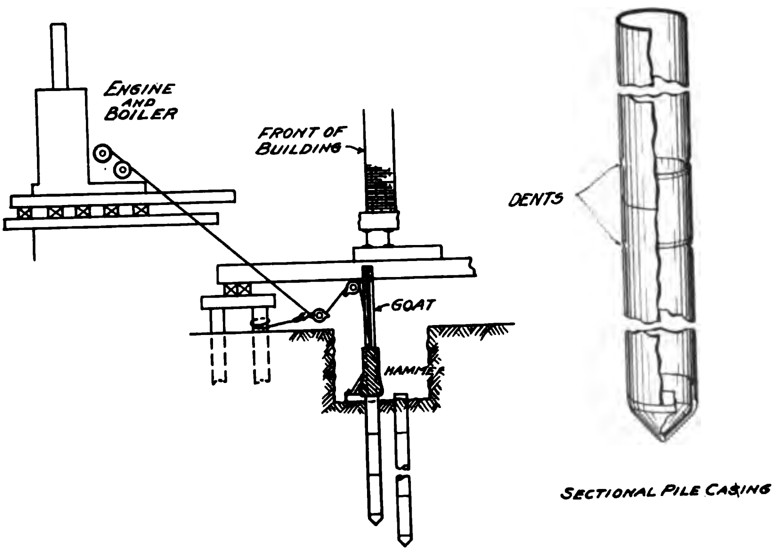


FIG. 2.—METHOD OF DRIVING PILES FOR UNDERPINNING BUILDINGS.

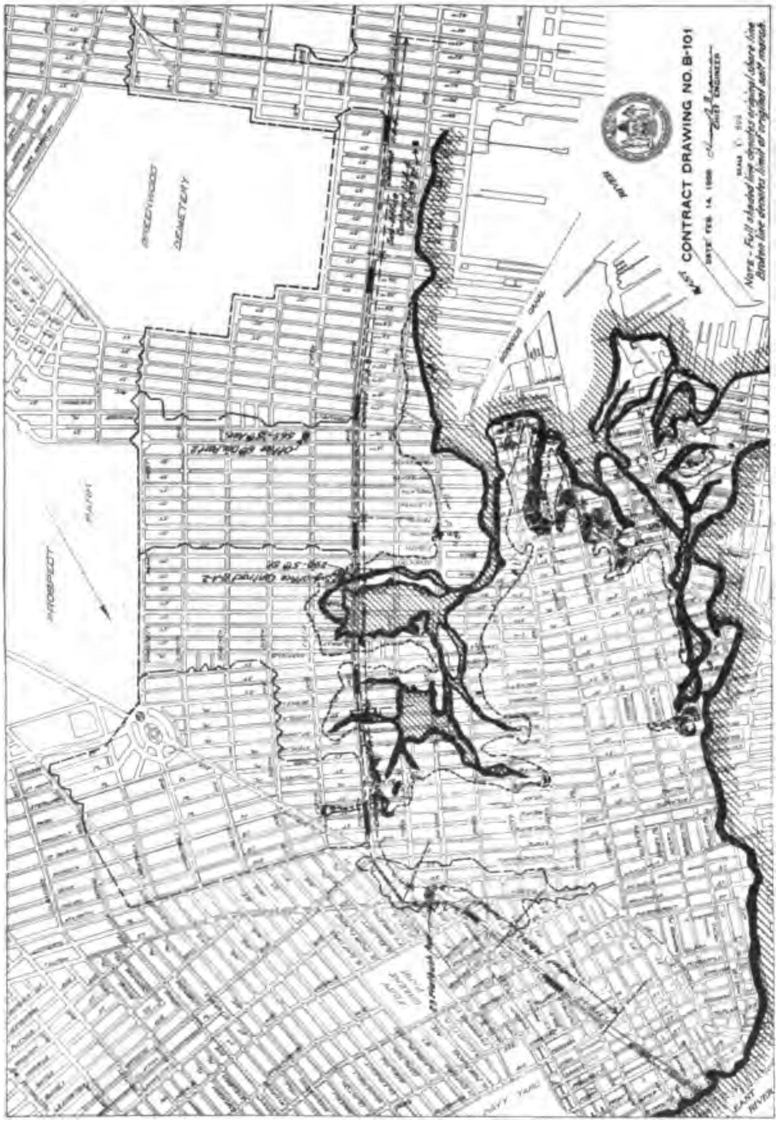


PLATE 77.—MAP SHOWING LOCATION OF SHORE LINE AND SALT MARSH IN 1776.

delivered in scows at Gowanus Canal and distributed along the work by means of teams. The interior walls and roof consisted of 1:2½:4½ mixture. Due to the contractor using reinforced concrete in the place of the usual water-proofing, all the concrete in floors and side-walls was mixed in the proportion of 1:2:4. Only a few thousand yards of sand fit for concrete were found in the excavation of the three contracts south of Sackett Street. The concrete on Section 11-A-2 and 11-A-4 was mixed by means of portable rotary mixers electrically driven and placed in such a position that the concrete passed from the mixer through chutes directly into the forms. The concrete was mixed wet in all cases, and the men used hoes for spreading it in the floor and roof. In the walls small wooden spades were used close to the forms, resulting in a very smooth finish of the concrete. The use of gravel in concrete instead of stone seems to be more economical because of the ease of handling. It gave very good results. About 1.7 cu. ft. of water was used for each two-bag batch of 1:2:4 concrete, being 14% of the volume of the aggregates measured loose or 19% of the volume of concrete.

In the winter the water was raised to a temperature of about 150 degrees, resulting in concrete being deposited in the forms at a temperature from 50 degrees to 60 degrees, varying with the temperature of the atmosphere. Concrete was placed without interruption from cold weather, except the 12-in. walls, in which concrete was not placed when the temperature of the air was below 20 degrees. Salt hay was used as a protection during freezing weather.

All forms used, except for jack arches, were of wood and designed by the contractor's engineer, so that they could be removed in panels or sections and were generally used from 15 to 20 times.

Even by exercising great care, it is difficult to maintain sharp edges on concrete. The handling of heavy timber and material tends to break the corners and give the edges a ragged appearance. To avoid this, the edges of the duct-bench and openings through the walls were chamfered.

For the jack arches between the steel-bents of the station, iron forms (No. 16 gauge metal) were used. In order to hold the 2 in.

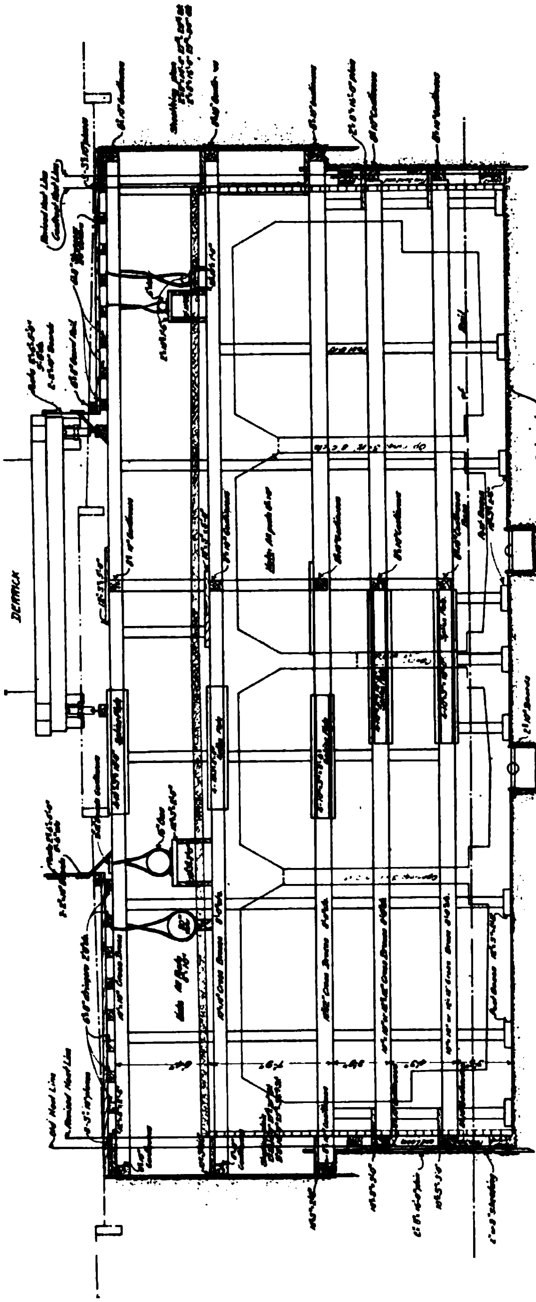


PLATE 78.—METHOD OF BRACING TRENCH ON E. E. SMITH CO. CONTRACTS. MIDDLE BRACE SUPPORTS BOTTOM OF TOP SHEETING.

of protecting concrete on the under side of girders, wire cloth of about 6 in. by 9 in. mesh was used.

The bottom of the subway for two-thirds of this contract and the whole of the contract from Twenty-seventh Street to Forty-third Street was below Elevation 101, and for this condition the contract drawings required the placing of brick in mastic between stations as well as in the stations. The contractor offered the city a rebate if, in lieu of the brick in mastic and 6-in. concrete base, he would be permitted to place additional longitudinal reinforcing rods and a richer concrete. The reinforcing consisted of $\frac{5}{8}$-in. longitudinal rods occupying 0.4 of 1% of the area of the concrete, the intention being to cause the shrinkage cracks to be many and small rather than one large crack. The contract was modified accordingly.

In ground-water where the original contract drawings showed a floor-slab 12 in. thick with 5 in. of brick in mastic under it, supported by 6 in. of foundation concrete, the revised contract required a concrete slab not less than 16 in. thick, reinforced in the same manner as shown on the contract drawings but having additional reinforcement of $\frac{5}{8}$-in. square, corrugated steel bars equalling 0.4 of 1% of the area of the concrete. Instead of $1:2\frac{1}{2}:4\frac{1}{2}$ mixture of concrete required by the original specifications, the mixture was made $1:2:4$. Where the contract drawings showed a thickness of 16 in. or more for the floor-slabs above the brick in mastic, this thickness was retained but the concrete was made of $1:2:4$ mixture and reinforced with $\frac{5}{8}$-in. longitudinal rods equalling 0.4 of 1% of the area of the concrete. The concrete of the side walls was reinforced in a similar manner and the brick in mastic was omitted. At stations where the construction was of steel bents, the two-ply fabric water-proofing was retained outside of a 10-in. concrete wall reinforced with 0.5 of 1% of longitudinal $\frac{1}{2}$-in. rods. This concrete took the place of the 8-in. brick in mastic.

The contractor used the greatest care in getting uniformity of mixture of concrete, spacing of rods and the cleaning of junctions of concrete placed on different days. It may be said that each slab was water-proof but the crack at the junction of two days' work was always present even though the extent was modified due to

FIG. 1.—BRACING OF SUBWAY TRENCH ON THE E. E. SMITH SUBWAY CONTRACTS (SECTIONS 11-A-2 AND 11-A-4).

FIG. 2.—SHEETING, HOLLOW TILE, BENT RODS CONNECTING FLOOR AND SIDE WALLS, AND VERTICAL RODS OF SIDE WALL ON SECTIONS 11-A-2 AND 11-A-4.

the overlapping of the rods and the care exercised in getting clean junctions of concrete.

At the time this question was under discussion, the writer opposed this method of water-proofing so important a structure as the subway.

Apparently, the method was successful, but we have no means of knowing this very definitely because there is no hydrostatic head outside of the tunnel, as yet.

While it was expected that ground-water would be found at about Elevation 101, test-pits dug near Carroll Street showed that water stood practically stationary at Elevation 92.5.

The test will come when some large trunk-sewer is built, possibly intersecting the subway route. During the construction of this, it is possible that the water from the canal will envelope the lower portion of the subway. Should the subway walls leak then, it is probable that the water would carry sufficient material in suspension to silt up the leaks in time.

The roofs of the stations at Union Street and Ninth Street were water-proofed by means of two layers of rock asphalt mastic each ½-in. thick and a protection of 4 in. of concrete. The rock asphalt mastic was composed of 60 parts, by weight, of Sicilian asphalt mastic received on the job in cakes; 10 parts of refined Trinidad asphalt as a flux, and 30 parts of clean, sharp grit passing a sieve of 8 meshes to the lineal inch. The ingredients were heated to 260 degrees and thoroughly mixed. The mastic was spread, while hot, with wooden spatulas, the thickness being determined by means of iron rods so placed as to act as "screeds" or guides. The results were entirely satisfactory.

Due to lack of cover, the placing of the roof had to be delayed. The bottom and walls had to be built first; then the 20-in. water main and gas mains were removed from over the tunnel to the side of the tunnel, permitting the roof concrete to be placed. In each block, there is an opening in the roadway of about 100 ft. in length and 6 ft. wide covered with gratings for ventilation. The roof between stations is not water-proofed but is covered with 6 in. of gravel which is intended to act as a drain, and the water reaching the edge of the roof is supposed to find its way rapidly into the ground through the 4-in. hollow tile at the side of the

tunnel. The roof was placed in slabs of about 32 ft. in length, the junction of one day's work with another was made as carefully as possible and a small cove about 3 in. deep and 1 in. wide was left in the concrete. This cove was afterwards filled with tar, the idea being that it would help the process of silting up of these cracks. In the writer's opinion, this method of treating the roof was entirely successful.

The total quantities on this contract were 225 600 cu. yd. of excavation, of which 39 000 cu. yd. were below mean high water, 53 700 cu. yd. of concrete, 2 050 tons of structural steel, 3 000 tons of steel rod. The daily average number of men employed was 385.

Mr. L. G. Burleigh was Superintendent, Mr. S. M. Purdy was Chief Engineer for the contractor, Mr. E. Holtmark and Mr. C. E. Thomson held the office of Section Engineer for the Public Service Commission at different times.

SECTION II-A-3.

On Fourth Avenue, From Tenth Street to Twenty-seventh Street.

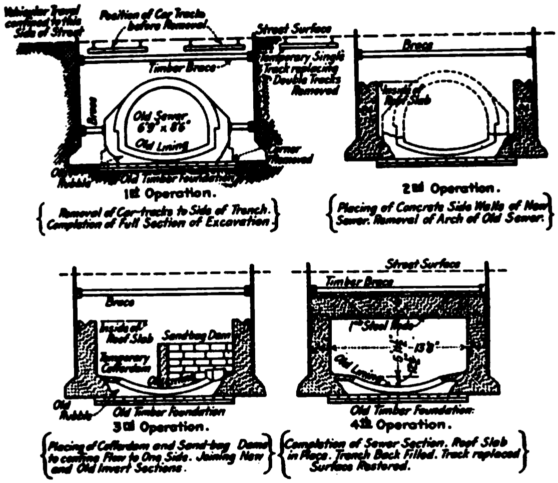
Tide Water Building Co. and Thomas B. Bryson, Contractor.

This section is 4 tracks wide and has a local station 435 ft. long at Prospect Avenue and at Twenty-fifth Street.

This section, like the one north of it, is at the base of a large water-shed, but all the work except 178 ft. at the south end was above mean high water.

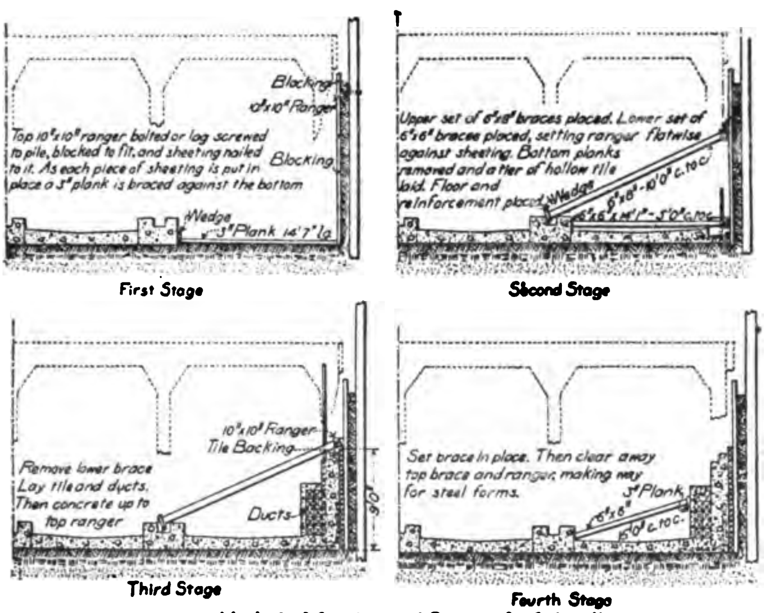
Actual work of excavation was begun on December 20th, 1909. Sewers, water and gas mains and other subsurface structures were removed from under the roadway of Fourth Avenue and rebuilt in permanent location under the sidewalk. Pressure gas mains, crossing Fourth Avenue, were maintained by suspending them about 20 ft. above the street by means of steel cables passing over masts on each side of the avenue. The Edison cables were temporarily supported on the fence of the west temporary roadway.

An off-line sewer had to be built in Twelfth Street and in Twenty-sixth Street. Plate 80, Fig. 1, shows the method employed and the successive steps taken in rebuilding an old off-line sewer in Third Avenue between Twenty-sixth and Twenty-seventh Streets.



Reconstruction of Third Ave. Sewer Near 80th St., in Connection With Fourth Ave. Subway Construction.

PLATE 80.—FIG. 1.



Method of Sheeting and Bracing for Sidewalls

PLATE 80.—FIG. 2.

To meet the requirements of the specifications, two 12½-ft. temporary roadways were built for the whole length of the contract. These roadways were supported by wooden piles driven just outside of the line of the subway, and later by raker braces. On April 23d, 1910, a 70-ton steam-shovel with a 2½-cu. yd. dipper began work of excavation for the tunnel trench near Fifteenth Street (Plate 81, Fig. 1).

The shovel loaded the excavated material into 6-car trains of side-dumping cars, holding about 4 cu. yd., hauled by 20-ton locomotives on a 3-ft. gauge track. These trains passed out of the cut and traveled over the surface of Nineteenth Street to the contractor's dump at Gowanus Canal. The material excavated was loam and sand, gravel and some boulders (Plate 82). The sides of the cut stood at a steep slope, requiring bracing and sheeting for only the lower half of the trench. The steam-shovel worked two 8-hour shifts from April 23d, 1910, to October 17th, 1910, and one 8-hour shift until November 28th, 1910. While normally 8 000 to 10 000 cu. yd. of excavation per contract per month is considered good work, the shovel took out from 30 000 to 40 000 cu. yd. in a month.

Plate 84 is typical of a series of diagrams designed by the author to show graphically the rate at which work of excavating, concreting, etc., should progress and the amount of work actually done later each month. When these charts were made there was no precedent that could be followed since the old subway took four years to build and the contracts just executed required the work to be completed in two years. The "criterion line" was drawn from the date of the executing of the contracts (November 9, 1909) to a date 4 months before the date set for the completion of the work. The criterion line for concrete was drawn so as to begin 3 months after executing the contract and end 3 months before completion of contract.

The criterion line for general progress (money diagram) covered a period of 24 months, of course.

The criterion lines thus established agreed closely with the work accomplished on Sections 11-A-2, 11-A-3 and 11-A-4, except the excavation for 11-A-3, which was done more rapidly than called for by our schedule.

FIG. 1.—STEAM SHOVEL ON SECTION 11-A-3.

FIG. 2.—EAST SHEETING BRACED TO CONCRETE FLOOR. NOTE EDISON CABLES SUPPORTED ON 8-FT. FENCE OF TEMPORARY ROADWAY.

Following the shovel, the floor concrete for the express tracks and the column footings for the center and the two quarter walls was placed (Plate 81, Fig. 2). Locomotive cranes on standard gauge track, were then used to trim up the corners along the sides of the cut and to set the sheeting.

The concrete was placed for the outside tracks, the ducts were laid, and the lower half of the side-wall was poured at the same time as the concrete enclosing the ducts (Plate 80, Fig. 2).

Steel forms were then placed for the roof and walls of four tracks and a length of 40 ft. of the tunnel (Plate 83, Fig. 1). These forms, designed by the contractor's engineer, were built of $\frac{3}{16}$-in. steel plates stiffened by means of channels and angles. The top panels, which form the roof and splays, were hinged so that the form could be collapsed inward (Plate 83, Fig. 2). The wheels on which the bottom of the forms rested had axles long enough to permit of sliding the forms inward 3 in. from the completed concrete. A locomotive hauled the forms forward into place for the next 40-ft. section in five to ten minutes. The steel reinforcing-rods for the walls and the wooden box-forms for the openings through the wall were all placed before the form was pulled forward. The steel rods on the roof rested on metal chairs properly spaced. The steel forms were greased with black oil.

The sand and gravel was hauled in trains from the dock at 19th Street to the large bins at Nineteenth Street and Fourth Avenue, being transferred from there to the hoppers over the mixer by means of belt-conveyors and bucket-elevators.

The central mixing-plant consisted of a rotary mixer, delivering a five-bag batch of concrete into 2-yd. bottom-dump buckets on cars (Plate 85, Fig.1). These were hauled to the work by locomotives. The buckets were raised by means of a crane to a hopper 10 or 12 ft. above the top of the forms (Plate 85, Fig. 2). The concrete ran by gravity from the hopper down an inclined wooden chute having trap-doors in it so the concrete could be delivered where required.

The placing of the concrete was usually begun at six o'clock in the morning so as to have the use of daylight in case of any accident causing the work to be prolonged beyond the usual 6 to 9 hours. A 40-ft. section of roof, three interior walls and half of

the two side-walls contained from 300 to 350 cu. yd. of concrete. Several sets of 80 ft. of completed tunnel were built in a similar manner; that is, 600 to 625 cu. yd. of concrete were placed by two shifts working on one 80 ft. form from 14 to 18 hours.

At first the forms were pulled in four days after the concrete had been placed, but during the warm weather this rule was modified and occasionally forms were slacked in 60 to 72 hours. The quantity of forms being limited, the contractor had to use them as rapidly as possible in order to complete his work in time. This gave rise to constant requests from the contractor to be allowed to pull the forms in shorter time. The writer believes that to pull forms from under a reinforced slab roof four days after the concrete is placed is a fair rule.

There being so much steel to absorb the heat from the concrete, large, coke-burning salamanders were placed under the steel form of each track and canvas was hung at each end so as to retain the heat (Plate 86, Fig. 1). The salamanders were in place 12 hours before placing the concrete and for several hours after it was placed. The water at the mixer was heated to a temperature of 150 degrees. Salt hay was used as a covering for the concrete.

During September and October of 1910 an attempt was made to deliver concrete by means of compressed air from the central mixing plant to its place in the forms. The compressor located in the trench below the rotary mixer between Eighteenth Street and Nineteenth Street discharged into a 4-in. wrought-iron pipe, which delivered the material several blocks away into a receptacle which had baffle plates in it to check the velocity of the concrete. From this it passed down inclined chutes to the forms.

There was a tendency to "choke" up the delivery pipe, and this difficulty was not eliminated by the substitution of a 6-in. pipe.

The concrete as delivered was well mixed and would have been in satisfactory condition for the work.

During the summer of 1911, the "cement-gun" was used with success in repairing the concrete on the under side of beams and girders in Prospect Avenue and Twenty-fifth Street Station.

The water-proofing on the roof of the stations at Prospect Avenue and Twenty-fifth Street was two ply of woven fabric and one layer of brick in mastic, while on the sides three ply of woven fabric was placed.

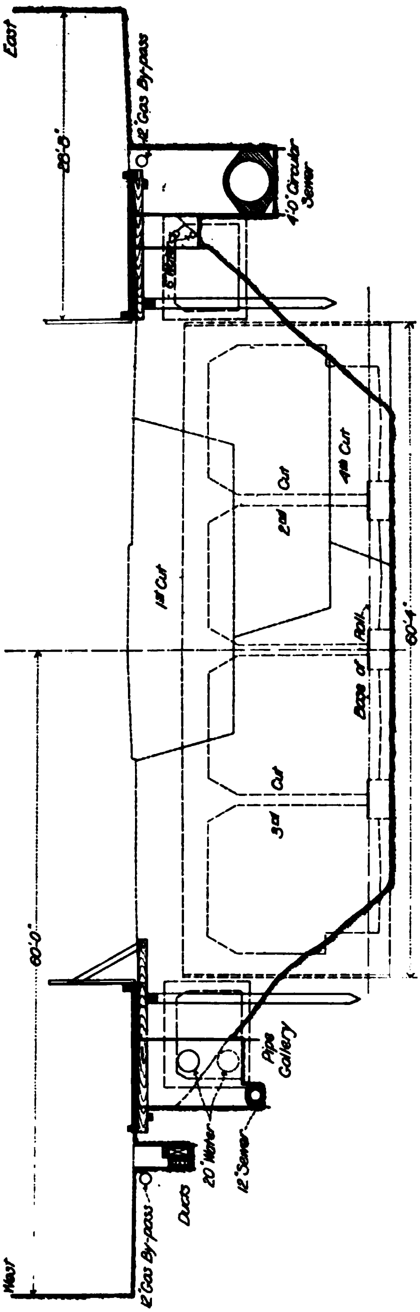


DIAGRAM SHOWING SEQUENCE OF STEAM-SHOVEL CUTS
SECTION 11-A-3, FOURTH AVE. SUBWAY.

PLATE 82.

When restoring sidewalks, we attempted the task of getting property owners whose fences extended 10 to 15 ft. beyond the house line to move them back to a line 7 ft. from the house line.

We found so much opposition that we abandoned the scheme, having achieved but slight success. City planning (correcting old errors) is an excellent project, but it is useless to make a map showing a street widened from 80 ft. to 120 ft., if we permit fences to encroach from 10 to 15 ft. on each sidewalk.

The removal of the ill-kept, unsightly "parkways" and substitution of the much smaller ventilating openings materially improved the roadway of Fourth Avenue.

The total quantities on this contract were: 290 160 cu. yd. of excavation, 60 400 cu. yd. of concrete, 2 000 tons of structural steel and 2 700 tons of steel rods. The average daily number of men employed was 325.

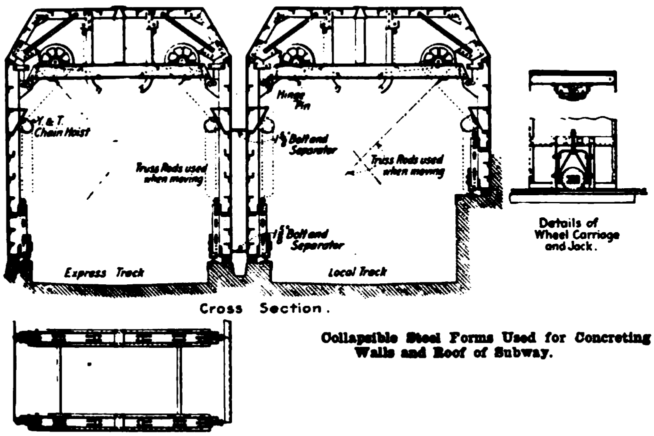
The Superintendent was Mr. Robert Eldredge. The Chief Engineer for the contractor was Mr. Stephen P. Brown. Mr. George Murgatroyd was Section Engineer for the Public Service Commission.

SECTION 11-A-4.

On Fourth Avenue, from Twenty-seventh Street to Forty-third Street.

E. E. Smith Contracting Co., Contractor.

This section is 4 tracks wide from Twenty-seventh Street to the express station at Thirty-sixth Street. At either end of this station, there is the usual bell-mouth to make room for the island platforms. At Thirty-eight Street the structure has 7 tracks and passes under the elevated road and the Culver Cut. Four tracks continue southward on Fourth Avenue at the upper level, while 3 tracks are depressed so as to pass under the Fort Hamilton tracks to form the beginning of the Coney Island Rapid Transit Route. The most easterly track branches toward the east from the track at the upper level. The ends are closed by means of temporary bulkheads. In order to construct the 3 depressed tracks, it was necessary to excavate a trench 70 ft. below the street with the subgrade 20 to 25 ft. below the water level. The contractor began work on December 10th, 1909.



Collapsible Steel Forms Used for Concreting Walls and Roof of Subway.

FIG. 1.

FIG. 2.—FORTY FOOT SECTION OF COLLAPSIBLE STEEL FORM FOR ONE TRACK. NOTE RAIL ON COMPLETED DUCT BENCH. SMALL WEDGE AT CENTER OF TOP MEMBER IS REMOVED WHEN FORM IS COLLAPSED.

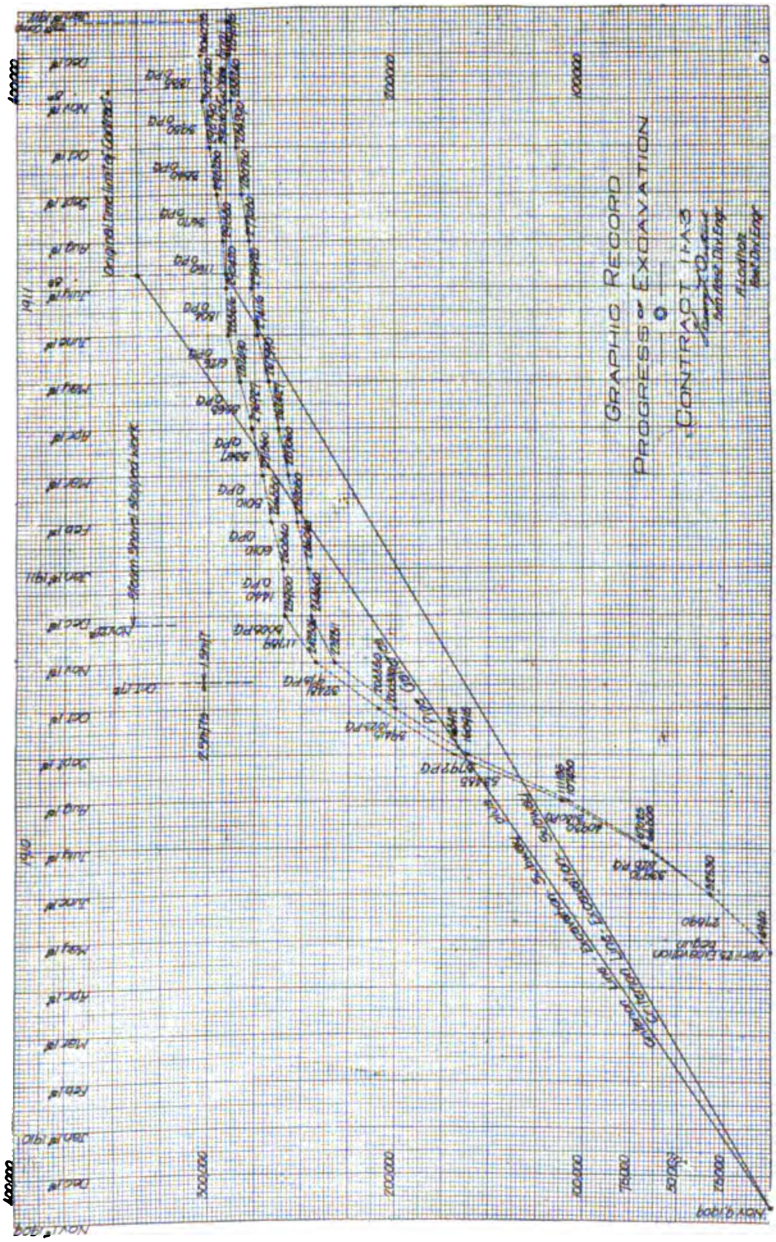


PLATE 84.

The general method of procedure on this contract was similar to that on 11-A-2, ten electrically driven, movable stiff-leg derricks being used to hoist the material to the surface from where it was hauled, by means of teams, to a dump behind the new sea-wall between Twenty-ninth Street and Thirty-fourth Street on New York Bay. The excavation was all loam and sand and about 20 000 cu. yd. was taken out monthly. Ground water was found at Elevation 101. This required constant pumping. The cut was sheeted with 2- and 3-in. sheeting and braced transversely with 10 by 10-in. yellow pine spaced 8 ft. center to center (Plate 79, Fig. 1).

The concrete was mixed with rotary mixers placed directly over the work so that the concrete could be delivered directly into the forms, by means of a chute.

Concrete was usually placed in 32-ft. sections in the floor and also in the roof. Occasionally, as much as 200 cu. yd. were placed by 2 mixers in 5 to 7 hours. No interruption in the placing of concrete occurred during the winter—the contractor heating the water used in the concrete to a temperature of 150 degrees.

In the southerly portion of this contract, much of the structure was of steel-beam construction, at considerable depth below ground water. On these walls 2-ply woven fabric and brick in mastic required by the original contract, were omitted and there was substituted 10 in. of 1:2:4 concrete outside of the backs of the I-beams. This concrete was reinforced with 0.5% of longitudinal ½-in. square corrugated steel bars.

The concrete below the embedded steel floor beams or girders was made of a thickness equal to the gross thickness from the bottom of the beams or girders to the bottom of the layer of concrete below the water-proofing, as shown on the contract drawings. Concrete consisted of 1:2:4 mixture and was reinforced with 0.4% of longitudinal ½-in. square rods.

On the roof of Thirty-sixth Street Station, two ½-in. layers of rock asphalt were placed as water-proofing instead of the 2 plies of woven fabric and 1 layer of brick in mastic required by the original contract. The rock asphalt consisted of 60 parts by weight of asphaltic mastic, 10 parts of Trinidad flux and 30 parts of grit.

The water and gas pipes were maintained, in the usual manner, by supporting them from the timbers (Plate 78). Where the large

PLATE 85.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
OESTREICH ON THE FOURTH
AVENUE SUBWAY, BROOKLYN.

Fig. 1.—Concreting. Crane Raising Bottom Dump Bucket from Train to Chute Over Steel Forms.

Fig. 2.—Concreting. Bottom-Dump Bucket Discharging Into Chute. Note Size of Slab and Absence of Post Holes in Roof Concrete.

FIG. 1.—CANVAS CURTAINS HUNG AT EACH END OF STEEL FORMS DURING FREEZING WEATHER.

FIG. 2.—SCREW JACKS FOR RAISING LARGE MAINS UNDER PRESSURE.

PLATE 87.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
OESTREICH ON THE FOURTH
AVENUE SUBWAY, BROOKLYN.

Fig. 1.—Center Wall. One Side of Form and Forms for Openings in Place. Note Method of Securing Rods in Position.

Fig. 2.—Method of Supporting Elevated Railroad Crossing, Fourth Avenue at 38th Street.

mains were in the way of the placing of the concrete in the roof, screw-jacks with 2½-in. stems and long handles were used (Plate 86, Fig. 2). Since these could be operated from the roadway through a small hole in the decking, they obviated the necessity of blocking traffic. These screw-jacks were designed by the contractor's engineer and were later adopted by other companies.

Plate 87, Fig. 1, shows the one form of the 12-in. reinforced center wall, the form on the near side not having been placed as yet. It also shows the box forms for the opening through the wall.

Plate 87, Fig. 2, shows the elevated structure and roadway near Thirty-eighth Street. Below this roadway, at right angles to Fourth Avenue, is the Culver Cut. Below this, longitudinally with Fourth Avenue, there is the double-deck structure of the subway. The 4 elevated columns located over the subway at this point were carried on 2 pairs of steel trusses, the ends of which were supported on wooden horse-heads, the bases of which were at the subgrade of the tunnel. A system of I-beams and brackets riveted to the elevated columns transferred the load to the trusses.

The sewers on this section were not very large and for the most part were built after the sides of the subway had been completed. There is one sewer syphon passing from east to west under the subway at Thirty-fifth Street.

The total quantities on this contract were 338 500 cu. yd. of excavation, of which 63 500 cu. yd. were below mean high water, 71 000 cu. yd. of concrete, 5 300 tons of structural steel, 3 300 tons steel rods. The daily average number of men employed was 430.

Mr. L. G. Burleigh was the Superintendent, Mr. S. M. Purdy was the Engineer for the contractor and Mr. John L. Hogan was the Section Engineer for the Public Service Commission.

For the Commission, Mr. Alfred Craven is Chief Engineer; Mr. Robert Ridgway, Engineer of Subway Construction; Mr. F. C. Noble, Division Engineer; Mr. S. Dahm, General Inspector of Designs, with Messrs. C. E. Conover and M. Allen in active charge of designs. Mr. A. Lodholz, Assistant Division Engineer. Mr. S. U. Hopkins and the writer were in charge of the three first and second sections, respectively, until September, 1911, after which time the writer was in charge of the six sections under the Division Engineer.

DISCUSSION.

E. H. MELLERT.*—The design and construction of the Flatbush Avenue Tunnel of the Fourth Avenue Subway presented unusual problems in Subway construction. It was necessary to plan and carry on the work in such a manner as not to interfere with operation of trains in the Interborough Subway under which the Fourth Avenue Subway passes. Under these conditions, the new Subway had to be built as a tunnel.

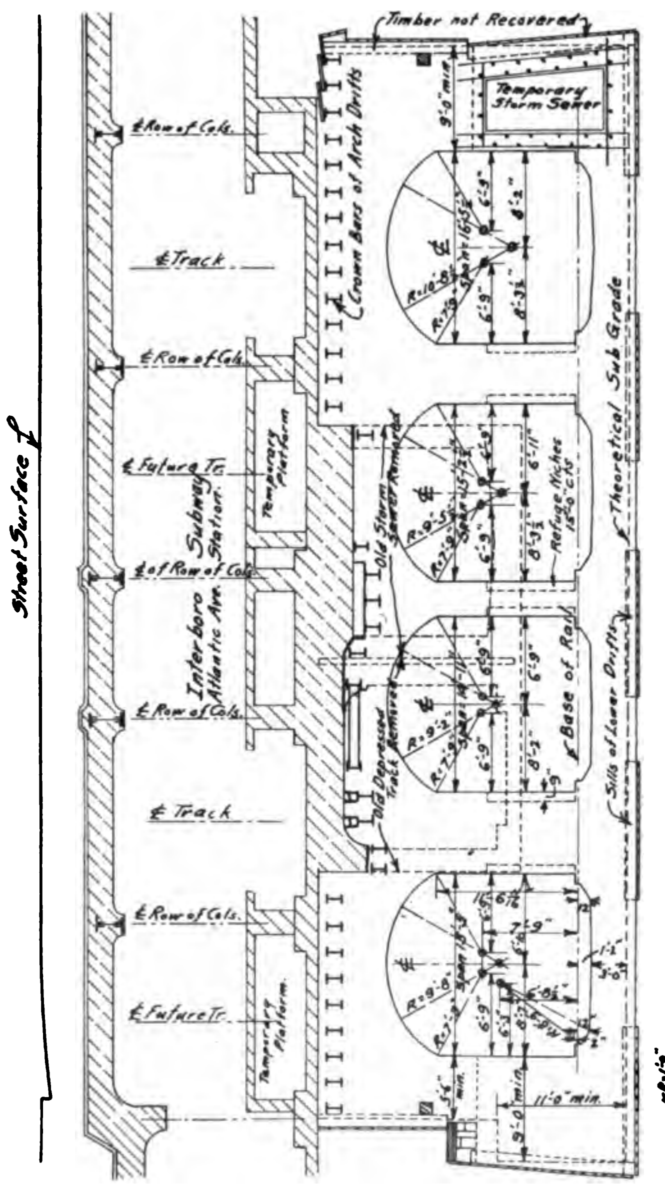
The old subway, in addition to carrying the street loads, carried also the double-track trolley line and the two-track elevated line in Flatbush Avenue, so that the loads to be carried in the new work were quite large. The track floor of the old subway consisted of a 14-in. layer of unreinforced concrete and was, therefore none too strong if undermined for any considerable area. Care had to be taken not to leave too great an area unsupported at a time.

The original design for the tunnel, which was presented by the Public Service Commission, proposed using steel-bent construction. This design was not considered feasible by the contractors because it would necessitate the undermining of large portions of the old subway at a time which they considered dangerous, and because of the difficulty in placing heavy steel in such close timbering as would be required. They therefore asked for plans and bids from several firms of consulting engineers. One plan submitted proposed four circular cast-iron tubes to be constructed by the shield method. The plan finally adopted was the one submitted by the engineering firm of Jacobs and Davies. This design is shown in plan and section, by Plates 88 and 89, and proposed a massive structure with plain concrete floor, walls and arches. Upon the acceptance of this plan by the contractor, it was approved by the Public Service Commission. Jacobs & Davies were then retained by the contractor as "Managing Engineers," and did the work on a force account basis, the contractor furnishing all necessary materials and paying all the labor, while Jacobs & Davies furnished the superintendence and labor. Mr. Oestreich, in his paper, has outlined the general features of the work and it is my endeavor to explain the method of construction more in detail.

The following method of construction was adopted:

Two shafts, approximately 15 ft. by 15 ft. in the clear, were sunk, one each side of the old subway to the subgrade of the new tunnel about 50 ft. below street surface. This work required about six days, working continuously day and night. 3-in. by 12-in. tongue and groove yellow pine sheeting about 20 ft. long was used at the

* Assistant Engineer, Public Service Commission.



Typical Cross Section of Tunnel looking North.

The Flatbush Ave. Tunnel. Section 11E1 of the 4 Ave. Subway.

PLATE 88.

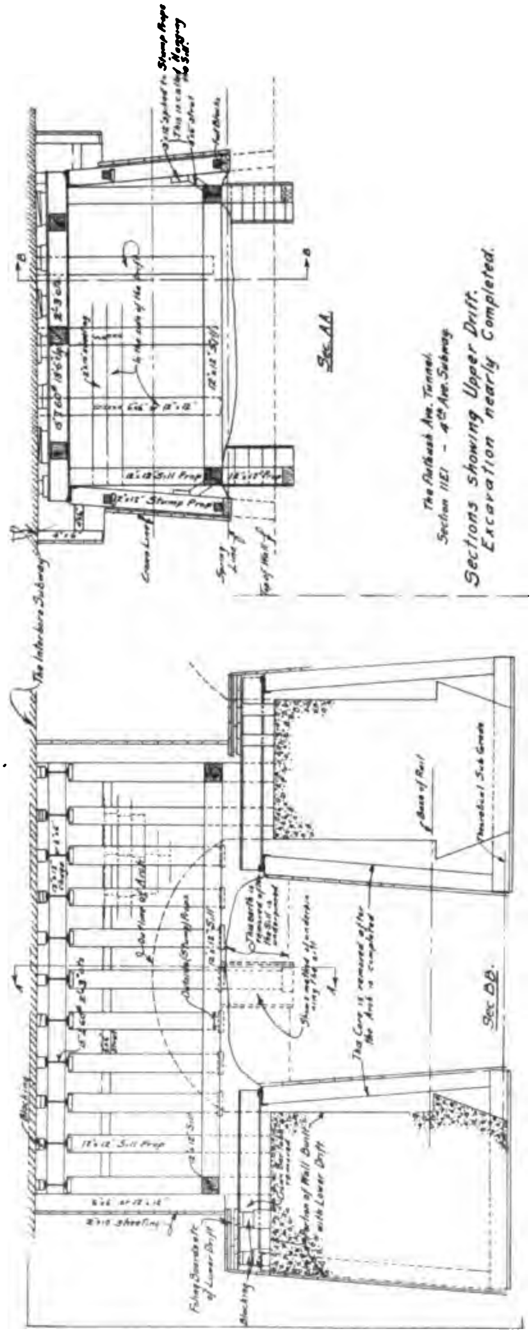
top of the shaft, being driven vertically to the level of the fifth frame of timbers from the top. The frames were placed horizontally, spaced 5 ft. center to center and consisted of 12-in. by 12-in. yellow pine timbers so that the east and west timbers extended past the ends of those on the north and south sides so that the thrust on them was resisted by the north and south timbers. The north and south timbers were held by a 12-in. by 12-in. strut across the center of the shaft from north to south. The frames were separated by 12-in. by 12-in. posts which also carried the weight of the frames and the vertical thrust on the sheeting. Below the fifth frame of timbers the same kind of sheeting was used but was driven vertically in short lengths from frame to frame. The frames were all the same as described except at the bottom of the shaft where provisions had to be made for breaking out for the cross-drifts. Plate 73A shows the location of the shafts, cross-drifts and wall-drifts.

When the shaft had been driven to subgrade, an opening was broken through the side toward the proposed cross-drift and a narrow drift about 6 ft. wide made to extend across the cross-drift at right angles to same. In this narrow drift the first two sets of timbers for the cross-drift were placed and then, working both ways, in the manner to be described for wall-drifts, the cross-drift was gradually made to extend to the full width of the new subway. The cross-drifts and shafts were planned to be entirely outside the limits of the old subway and approximately parallel to the outside walls of same. The new tunnel lies entirely between the two cross-drifts.

Upon the completion of the cross-drifts, which were made wide enough to accommodate two narrow-gauge construction tracks (about 11 ft. in the clear), openings were made in the side of the cross-drift at each wall of the new subway, for the starting of the wall-drifts. These wall-drifts were made wide enough to accommodate the entire thickness of wall, and, when possible, a narrow-gauge construction track, besides, and high enough (about 13 ft. in the clear) to allow the walls to be built to a height of from 2 ft. to 3 ft. below the springing line of the arch.

WALL-DRIFTS.

A typical section of the wall-drifts is shown on Plate 90. The regulation timber set consists of a 12-in. by 12-in. sill resting on 3-in. by 10-in. mud sills, which forms a bearing for two 12-in. by 12-in. side legs which support the crown bar (15-in. I at 60 lb.). The side legs or side trees take the thrust on the sides of the drift and this thrust is resisted at the bottom of the leg by the friction between the leg and the sill, and by a 3-in. by 10-in. spreader placed on top of the sill, and at the top, the thrust is resisted by a special



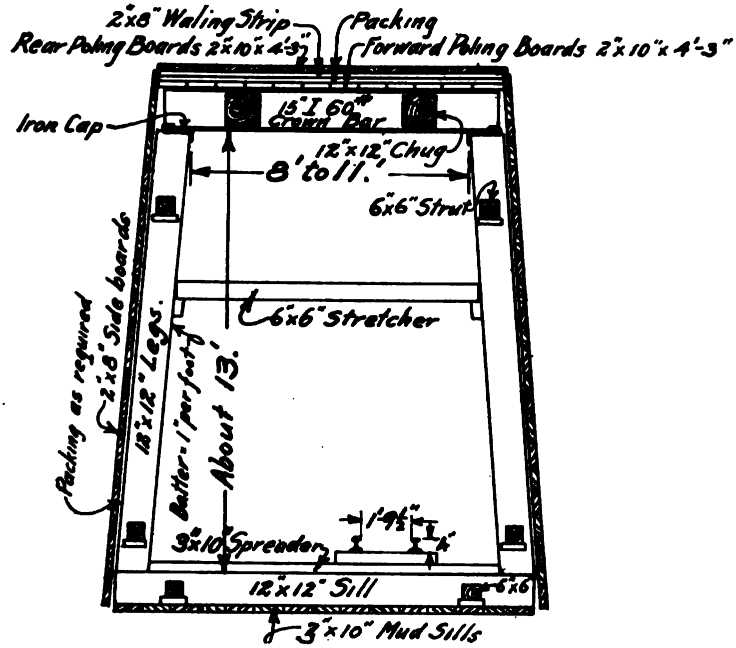
Sec. A.A.
Sec. B.B.
The Flatbush Ave. Tunnel.
Sections showing Upper Drift.
Excavation nearly Completed.

PLATE 59.

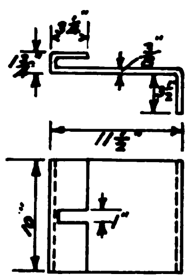
iron cap, shown in detail in Plate 90, which hooks around the end of the crown bar and the inside of the leg and acts as a bearing plate for the crown bar. Struts or chugs were placed between the sills, side legs and crown bars of adjoining sets to keep them spaced and to transmit the thrust from the heading or face of the drift. The earth at the sides was retained by 2-in. by 8-in. side boards placed horizontally to span between the side legs, and the earth over the drift was held by 2-in. by 10-in. poling boards spanning between and over the crown bars. A complete heading and face consisted of 2-in. by 10-in. breast boards placed horizontally in two sections to a height of about two-thirds the drift, held by 6-in. by 6-in. "soldiers" and 6-in. by 6-in. stretchers, braced against the 12-in. by 12-in. walking stick, and 1-in. by 6-in. boxing-down boards above these, placed horizontally in three sections behind 2-in. by 8-in. vertical boards called "legs." These legs are held by a 2-in. by 6-in. waling piece blocked against the needle beams.

A timber set and face being completed, as shown on Plates 90 and 92, the method of procedure is as follows: The center section of vertical legs in the heading is removed, leaving the boxing-down boards in view, and poling boards are driven forward over this section through the space left for them over the leading crown bar. As they are driven ahead, the soil under the point of the boards is gradually removed until the boards are about half way to the next timber set (about 1 ft. 9 in.). The poling boards now act as cantilevers, being held over the leading crown bar and being blocked at their rear ends against the rear poling boards and free at the front end with the earth above the forward end bearing down. They would break if driven further without additional support. To provide this support, the earth under the boards is gradually removed and the small heading made as sheeted down. Two 4-in. by 6-in. props supporting a 4-in. by 6-in. cap are placed under the forward ends of the poling boards in this heading and wedged up. The poling boards may now be safely driven ahead to full length, 3 ft. 4 in., to the next set. The soil is again gradually removed from under the poling boards and the heading advanced and boxed or sheeted down.

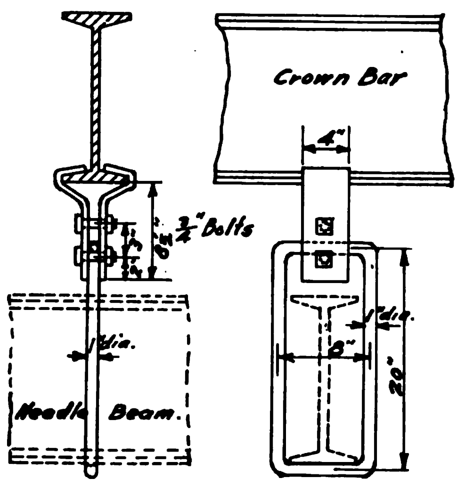
The poling boards over the two side sections of the face are then driven ahead in the same manner as that just described for the center section. After the heading is advanced full length and has been sheeted down full width, the new crown bar may be placed and some of the load on the poling boards transferred to it. This leading crown bar (see Plate 92) is supported on the forward end of two needle beams which act as cantilevers, being supported by means of special hangers (detailed on Plate 90), and being blocked at the rear end against the crown bar of the third set in the rear.



Typical Section of Lower (Wall) Drift - Excavation Completed.

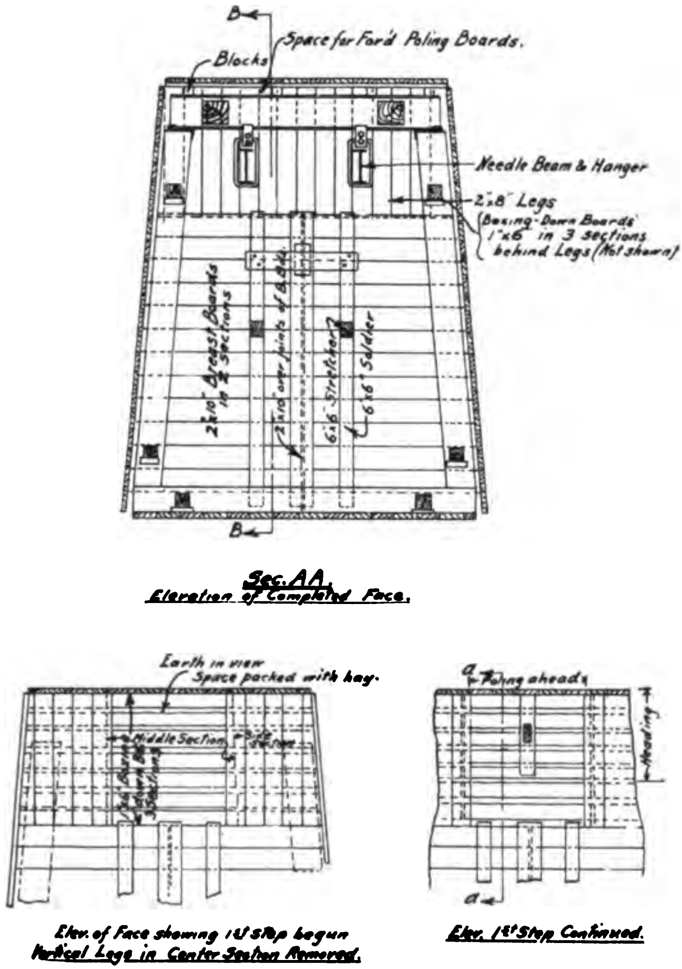


Details of Iron Cap.



Details of Hanger.

PLATE 90.



Sketches showing Method of

PLATE 91.

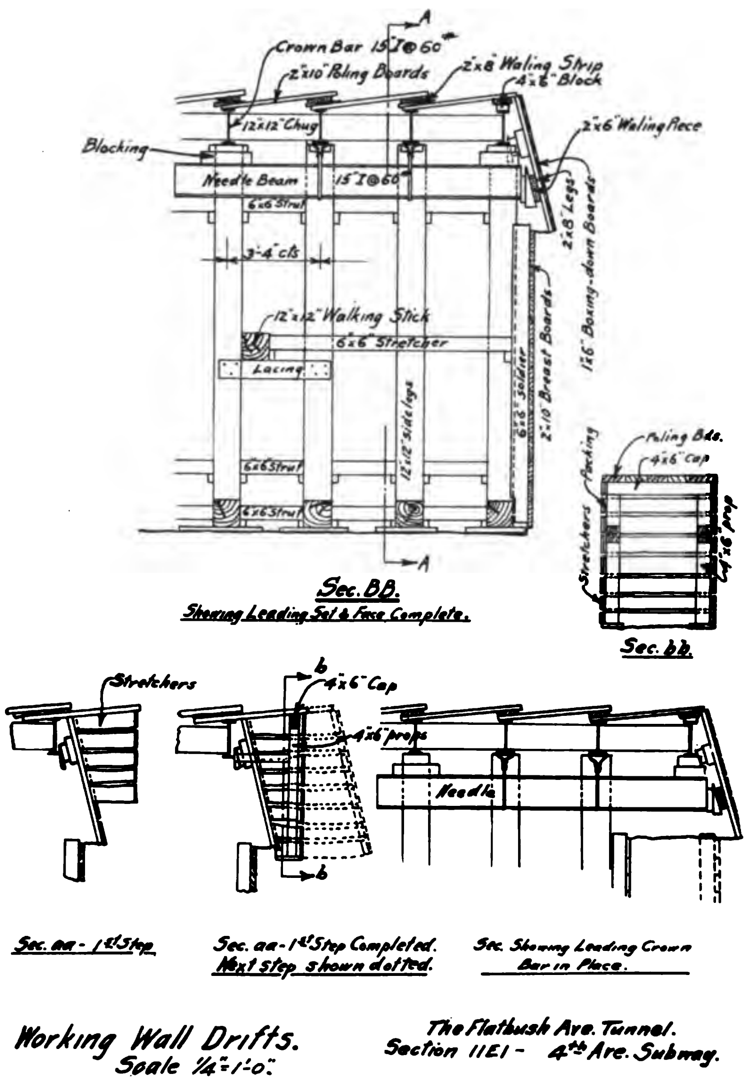

Crown Bar 15" I @ 60#
2"x10" Poling Boards
2"x8" Waling Strip
4"x6" Block
2"x6" Waling Piece
12"x12" Chug
Blocking
Needle Beam
15" I @ 60#
6x6 Strut
3'-4" c/s
2"x8" Legs
1"x6" Boxing-down Boards
12"x12" Walking Stick
6"x6" Stretcher
Lacing
6"x6" Soldier
2"x10" Breast Boards
12"x12" Side legs
6x6 Strut
6x6 Strut
A
A
Sec. BB.
Showing Leading Set & Face Complete.
Poling Bds.
4"x6" Cap
Packing
Stretchers
4"x6" prop
Sec. bb.
Stretchers
b
4"x6" Cap
4"x6" props
b
Needle
Sec. aa - 1st Step
Sec. aa - 1st Step Completed.
Next Step shown dotted.
Sec. Showing Leading Crown Bar in Place.
Working Wall Drifts.
Scale 1/4" = 1'-0".
The Flatbush Ave. Tunnel.
Section 11E1 - 4th Ave. Subway.

PLATE 92.

In putting the leading crown bar into place, a 2-in by 8-in. waling piece is placed under the forward ends of the poling boards and a space of about four inches is left between the waling piece and the crown bar by blocking, to allow room for driving the next length of poling boards.

The heading now being completed, the face is next breasted down. This is a simple process compared with that of boxing down the heading and is done in two sections, each one-half the width of the drift. Soil is removed near the bottom of 2-in. by 8-in. legs of the new heading, and a new forward breast board is placed and stretched back to the side leg in the rear and a temporary "soldier" in the middle of the drift, by the new side boards which are placed. This process is repeated until the face is breasted down to subgrade, the old breast boards being removed as it becomes safe to so. The face is then braced against the 12-in. by 12-in. walking stick by means of 6-in. by 6-in. "soldiers" and 6-in. by 6-in. stretchers, as shown on Plate 92. This then permits the placing of mud sills and sills upon which the side legs are then erected and wedged up to receive the load from the leading crown bar. When this is done, the needle beams which have so far supported the leading crown bar can be removed. The side boards having been packed against the new 12-in. by 12-in. legs and the 3-in. by 10-in. spreader placed over the sill, the new set and face are completed and we are ready to proceed to the next set.

The work of advancing the heading and face had to be done very carefully to prevent runs of sand. Whenever a run started it was stopped as soon as possible by stuffing hay into the opening. The joints in the sheeting were also packed with hay to prevent runs of sand. The earth excavated was shovelled into dump cars which were pushed along construction tracks in the wall and cross-drifts, to the shafts and there hoisted to the surface on cages.

As soon as a wall-drift was driven through, carpenters were put at work erecting forms for the wall. The forms were made of 2-in. by 8-in. lagging dressed on one side, held by 4-in. by 6-in. uprights which were braced against the sides of the drift. As the walls were to be built in advance of the floor, it was decided to skew the bottom of the walls so that they would have a bearing on the floor and so distribute the load onto the floor. The concrete was mixed on the surface and lowered down the shaft in dump cars and pushed to the forms, where it was either dumped or shovelled into the forms. The walls were built to about two or three feet below the spring line. When the concrete of the two west walls had been placed (they were the first completed), excavation was started for the arch between them in two places. In both places a start was made by breaking through the walls of the old

depressed track and making a narrow drift about 5 ft. wide parallel to the center of the new track. In this drift the first I-beam was placed and the drift was then widened out, working both ways.

Arch Drifts.

The typical section used in working the arch drifts is shown on Plate 89. In the case of arch drifts under the old subway floor, the earth was removed up to the floor (see Plate 75, Fig. 1). Where outside the limits of the old subway floor, poling boards were required to retain the soil above.

The arch drift was started by making a narrow drift near the center of the arch parallel to the track center line and long enough to extend to the other end of the section of arch to be built. In this drift two crown bars (15 in. I 60 lb.) were placed and supported on stump props (12-in. by 12-in. yellow pine) at the ends and on temporary props between them, and the floor of the subway blocked on the crown bar. This narrow drift was then widened out on each side and new crown bars and timber props placed, advancing from set to set in about four sections in much the same manner as described for wall drifts, using poling boards where necessary. When the drift had been widened full width the 12-in. by 12-in. sills and sill props were placed to relieve the stump props and temporary props. The sills were supported on short posts placed in pits excavated to the bottom of the finished arch drift so as to permit excavation to progress without danger of undermining the sills and stump props. The temporary props could then all be removed, leaving a clear space 15 ft. long and the full width of the track and walls, as shown on Plate 89. The I-beams in the top were placed 2-ft. 3-in. cts. and the subway floor blocked onto them. While working the arch drifts, 12-in. by 12-in. posts were placed quite close together so as not to leave the old floor unsupported for any considerable area.

The centers for a 14-ft. section of arch were then erected in the cleared space. The centering consisted of wooden trusses spaced 3 ft. 4 in. c. to c. supporting 2-in. by 4-in. lagging boards (see Plate 75, Fig. 2). The concrete was placed under difficulties, as it was necessary to handle same three or four times between the dump cars and the center. The concrete over the walls was placed first working up and toward the center of the arch, packing in between the crown bars as well as possible to prevent voids, and inserting at least one grout pipe in each space between two crown bars to provide means of grouting all possible voids. As more concrete was placed, the space in which the men worked gradually became smaller and they had to get out one by one by dropping

through the center. On reaching the middle of the arch, the concrete was placed drier and packed until a space about 2 ft. by 3 ft. by height of arch was left unfilled, when only one man could work. He would then back out and the hole in the center was lagged up and a grout pipe inserted in the space and same filled up by pumping grout, thereby completing the arch. The average time for completing the excavation of an arch drift for a 14-ft. section of arch over one track was about one week, working three shifts. The erection of centers and concreting of the arch took about four 8-hour shifts.

As soon as the arches over any one track were completed, the work of excavating the core of earth between the wall drifts and under the arch was begun, and after a stretch of about 30 ft. had been cleared out to subgrade the floor concrete was placed. Then more core was excavated, and so on, until the bottom was all in.

The final operation was the grouting of the voids over the arches between the crown bars of the arch drifts, by forcing grout or "Lias lime" through the 2-in. grout pipes placed in the arch for the purpose (see Plate 76, Fig. 1). For this a compressed-air grout machine was used.

Wherever the old depressed track and storm sewer were encountered they were removed by cutting out or blasting the brickwork and concrete. Previous to driving the tunnel the track and sewer had been timbered, and as the drifts were driven, these timber bents were caught upon the crown bars of the drifts.

The method of tunneling here used is a combination of the German and English systems of tunneling. It is the German method in so far as the sequence of the work is concerned, and the English method as regards some of the details. The usual disadvantage of the German system, the fact that the hauling of excavated material in the drifts interferes with the progress of the carpenters and masons building the walls, was not felt on this work because the tunnel was so short that it was not necessary to begin work on the walls until the wall drift was completely excavated. The method was very well adapted to this particular work and very successful.

E. G. Haines.*—Mr. Oestreich in his paper has referred to the underpinning of the Academy of Music in Brooklyn, but has not given a description of the methods employed or the results obtained.

It seems to me that the underpinning of this building is worthy of a detailed description as a matter of public record; and, while not a member of your Society, inasmuch as I am familiar with the work, I am pleased to submit the following brief description of the principal points of interest:

* Assistant Engineer, Public Service Commission.

The Brooklyn Academy of Music is a large building, highly ornamental in character, both as regards the exterior and the interior finish. It is a building of which the people of Brooklyn are justly very proud. The building occupies the entire block between St. Felix Street and Ashland Place, fronting on Lafayette Avenue, and extends along Ashland Place a distance of 200 ft. The subway line passes through Ashland Place at a distance of about 8 ft. from the building, and at this point has a depth of 50 ft., the bottom 8 ft. being in sand below ground-water level. The building has a steel frame which carries all the dead and snow load of the roof, the loads on all the floors, including the balconies, and was designed to carry, also, the dead weight of all the masonry above the first balcony level by means of channels and I-beams connected to the columns of the frame, which are spaced about 18-ft. apart and buried in the masonry walls of the building. Under normal conditions the weight of the walls below the first balcony level, including the basement and cellar walls, would be carried by the supporting ground beneath the building. During the progress of the underpinning, however, as the soil was cut away partially from beneath the walls, and entirely from beneath the columns, the weight of this additional masonry also had to be carried by the system adopted for the underpinning.

The loads on the columns, as shown by the computations for their design, were extremely heavy and varied from 180 to 320 tons per column. Added to the dead weight of the walls below the first balcony level, it is probable that in some cases nearly or quite 400 tons was carried by the false work provided for supporting a single column.

The underpinning proceeded in substantially the following manner, which was varied slightly to suit local conditions: After the street and sidewalk had been decked with heavy timbering, the excavation for the subway proceeded to about the bottom of the foundations of the building. This depth varied, for the reason that beneath one end of the building where the stage was located, there were two stories or levels beneath the street, which were utilized for machinery for operating curtain hoists, etc. Beneath the auditorium floor was a single level, or basement, used as a plenum chamber for heating the house, with a floor inclined at the same grade as the orchestra chairs; while beneath the foyer, at the opposite end of the building, was a basement and cellar. In the basement was located the switchboards, dynamos and other machinery for operating the house, and in the cellar was located the boiler plant and coal bunkers. The entire space beneath the building was a perfect labyrinth of small rooms and cells which made frequent changes from any fixed design for the underpinning

necessary. After the excavation had proceeded to the level of the footings, openings were cut through the walls at the location of each column. These were about 5 ft. wide and exposed the column from the base of its casting to about 8 ft. above. Through the openings so made needle beams were placed. These consisted of 24-in. I-beams at 120 lb. per ft., about 25 ft. in length. The number placed depended upon the load to be carried and varied from a total of four to a total of eight for a single column. These I-beams were placed as low down as possible and packed tightly against each other and against the column. The inner ends rested on a low timber grillage on the cement floor of the basement, while the outer end was on a timber crib sunk in a pit, the size of the crib being about 9 ft. square at the bottom and tapered up to a small bearing underneath the outer end of the needle beams. These beams were carefully leveled up and fastened together by bolts, and in some cases, by riveting angles across the flanges near their outer ends. Above the needle beams sufficient rivets were then cut out of the flanges of the columns to permit of placing a single channel at right angles to the needles. The channel was then placed against the cover plates, holes drilled to match those in the column and it was bolted in place. This was continued on one side of a column until three, and, in some cases, as many as five channels had been placed and bolted in position. The same process was then followed on the opposite side of the column, and when all the channels were in position the bolts were removed and replaced with rivets. The shoring for one column is shown by Plate 93, Fig. 1.

On account of the extremely heavy loads it was not always possible in the restricted space to obtain channels of a size which would suit the requirements, and some of the channels were made by coping one flange from 24-in. 120-lb. I-beams. The outer ends of the channels were stiffened up by riveting a heavy angle, placed vertically, to all the channels. The space between the channels from the column out to the end of the channels was also packed solidly with timber bolted in place. After these connections had been made 90-ton jacks were placed under the outer ends of all the needle beams, and they were pumped up until the beams showed a slight deflection. No attempt was made to lift the columns from their seats, and the amount of the deflection placed on the needle beams was simply a matter of judgment on the part of the engineer and foreman on the work. After a strain had been taken on the needling it was usually allowed to stand for a day or two, and then tried again with the jacks. Before proceeding with the excavation wedges were driven between the needles and crib.

When it was thought that the grillages had reached a firm bear-

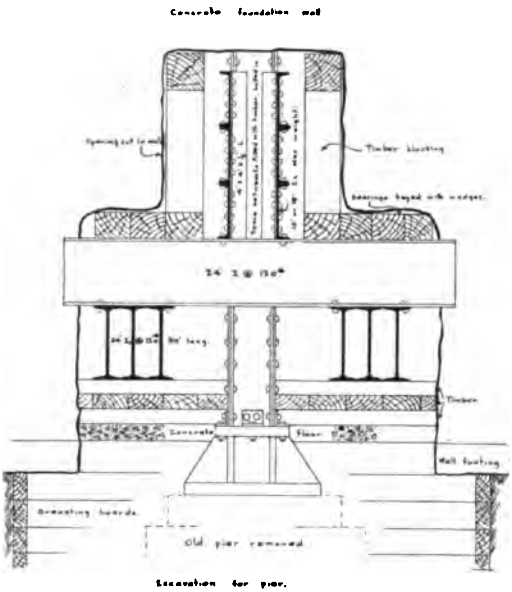


PLATE 93.—FIG 1.

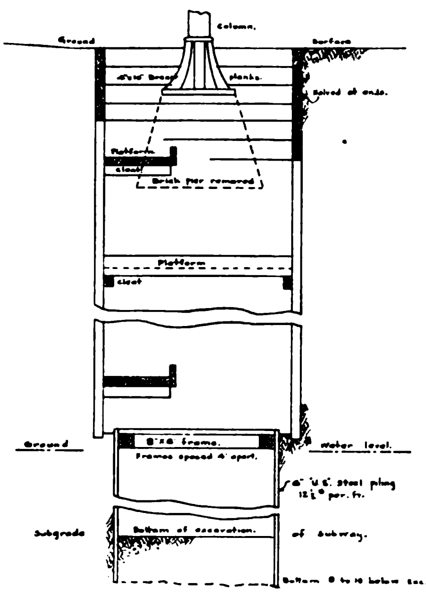


PLATE 93.—FIG. 2.

ing the concrete column bases or piers were broken up and removed and the excavation proceeded. This was done by the usual method by the use of horizontal sheathing or well-curbing with the ends halved together. The plank used for this purpose was 4 by 10 in. The planks were placed at the bottom as the excavation proceeded, and the spoil excavated from the pits was removed by casting up from one platform to another until it reached the top. Excavation proceeded in this manner to ground water level. At that point an 8-in. by 8-in. timber frame was placed of a size just sufficient to leave room on the outer side for placing a set of interlocking steel sheathing of the United States pattern, with room for operating an air hammer. This steel sheathing was in length sufficient to reach about 4 ft. below the proposed bottom of the underpinning pit, which in turn was about 2 ft. below the sub-grade of the subway. Within, the steel sheathing excavation proceeded as far as possible without the use of a pump, and after pumping was started the excavation was carried on continuously until the bottom was reached. This was usually accomplished in one shift. After the excavation was completed the water was allowed to rise to its normal level. The entire pit was then filled with $1:2\frac{1}{2}:4\frac{1}{2}$ concrete, in which a considerable quantity of large stones was placed. This concrete was brought up to within about 4 in. of the columns and allowed to set for a week or ten days before the base was grouted in with a one to one grout.

Before the excavation of any pits were started a number of columns were placed on the needles, but in excavating only alternate piers were carried down at any time in order that there might be one column on the needling and also its original base as a matter of precaution. After the grout under a column had been allowed to set, the needles were slacked off with the jacks, the channels removed in the reverse order of their placing and the openings in the walls restored with concrete. The method of sheating is shown by Plate 93, Fig. 2.

The size of each pier was sufficient to satisfy the Building Department requirement of a load not in excess of 4 tons per square foot, which required that the piers vary in size from 9 ft. by 9 ft. to 12 ft. by 12 ft. Cross buntons were used in the large pits.

At one end of the building there is a sidewalk vault, which extends beyond the line of the subway, but at an elevation sufficient to allow the subway to pass beneath. On account of the fact that the roof beams of this vault carry a portion of the load of the face masonry of the walls it was deemed advisable to maintain the vault in its present position, and an arrangement was made

whereby it would be carried over the roof of the subway by means of cantilever beams. These cantilevers were arranged to extend into the concrete piers placed beneath the main columns of the building, and rested across an auxiliary pier placed just outside of the line of the subway which acted as a fulcrum. Longitudinal beams were placed between the ends of the cantilevers beneath and along the wall of the vault to form a continuous support. The entire cantilever system is to be encased in concrete when the work is completed. The system is shown by Plate 94.

We frequently hear and read of heavy buildings which have been underpinned, and the statement is usually made that the work was successfully accomplished. Nevertheless, some of us who are familiar with the inside of the matter know that many of the buildings are cracked, and that it does not take a microscope to reveal that fact. For that reason I somewhat hesitate to give the results at the Academy of Music, as, up to the present time—although the work has been practically completed for nearly a year—there are absolutely no cracks which show either in the exterior walls or the decorations inside above the level of the street. Levels taken at frequent intervals for the past two years, and almost daily during the time the work was in progress, show that the maximum settlement, which has long since ceased, does not exceed one-quarter of an inch. Beneath the level of the street there are a few cracks in the basement walls, and there is also a crack which extends through the cement floor of the basement the entire length of the building. This varies from a fine hair-line crack to one about ¼ in. in width. It follows generally the line of the old joints of the cement floor. These cracks are due to what the writer believes to be the greatest source of danger in underpinning work, although it is one which usually receives very little attention. He refers to the liability of the entire wall moving outward due to the pressure of the earth behind the underpinning piers when the excavation for the subway or other structure is made in front of the piers.

Before the underpinning of the Academy was undertaken some computations were made according to several earth pressure theories, and it was believed that, owing to the immense size of the piers and the great loads which were added to the top from the weight of the building, the piers alone would be sufficient to act as a retaining wall and to support the building, had it been desired to excavate the cut in front without timbering. As a matter of fact, the cut was heavily timbered and the timbering was braced directly against the underpinning piers of the Academy of Music. Nevertheless, the wall did move slightly, as shown by the crack through the basement floor. While this crack is of no great conse-

quence, as it can be easily repaired by pointing, it is an example of how little dependence can be placed upon the usual earth pressure formula, as, according to all computations, the piers should have had a factor of safety of at least two against any motion whatever. The fact that no cracks have appeared above the street level from this cause is, of course, due to the fact that the steel framing of the floors is tied into the columns and the walls at that height.

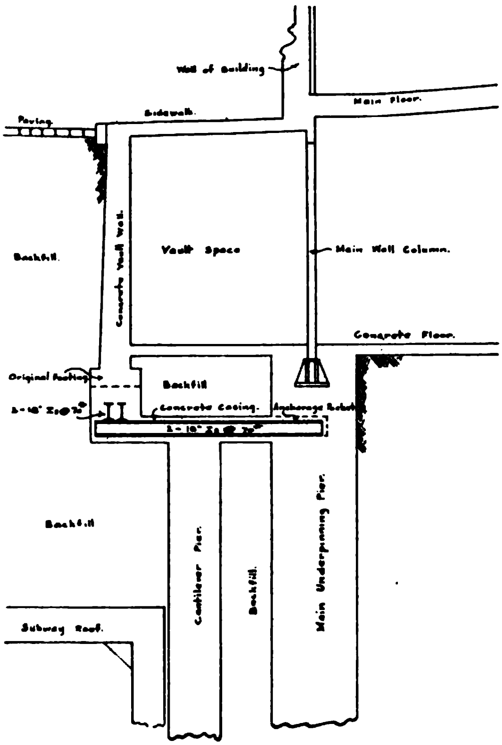
All things considered, the writer believes the underpinning at the Academy of Music to be one of the most successfully completed pieces of underpinning of which he has any knowledge, although he has been connected with work of that character for a number of years. It is not at all unusual to find that the front walls of underpinned buildings have moved out as much as an inch, and the writer knows of a number of cases where the amount is much in excess of that figure.

SAMUEL M. PURDY.*—Mr. Oestreich's very interesting paper gives a very complete and effective description of the salient features of the Fourth Avenue Subway and little remains that can be said on the subject. However, the writer desires to emphasize one or two matters which developed during the construction of Stations 11-A-2 and 11-A-4 which may be of interest to engineers who are engaged in similar work.

Those who are accustomed to handling large quantities of concrete are becoming more and more impressed with the superiority of washed gravel and broken stone as ballast for concrete. Gravel similar to that used on Fourth Avenue is easily obtainable in the New York market. This material consists of clean pebbles ranging in size from ¼ in. to 1½ in. in diameter, and weighs, when dry, 110 lb. per cubic foot, possessing but 33% of voids. The small percentage of voids allows, in the average mixtures specified, a large surplus of mortar which tends to increase water-tightness and greatly augments density. The round pebbles give greater plasticity, allowing the concrete to flow through chutes at a flatter slope and, in general, permit of easier handling. The same amount of water yields a concrete which appears much whiter than a broken stone concrete of the same proportions. This latter is a distinct advantage, as easy working concrete is obtained without drowning the cement.

On Sections 11-A-2 and 11-A-4 no ramming or spading was done; the concrete after being deposited was puddled with long wooden strips sharpened at one end to a chisel point. The sticks were agitated up and down in the mass and around the reinforcement, and the method was found to give excellent results both in the face or surface of the concrete and in the bond between concrete and steel.

* Chief Engineer, E. E. Smith Contracting Co.



Section at Vault.

PLATE 94.

There are other advantages in gravel which may be said to accrue chiefly to the benefit of the contractor, though, indirectly, they affect the cost to the owners by permitting cheaper bids. Of these may be mentioned: the saving in cement, the ease in excavating with clam-shell and similar buckets; the facility with which flow is maintained through gates and hoppers; less work in shovelling, and the greater rapidity with which a batch can be mixed.

An effort was made to deliver the concrete as quickly as possible from the mixers to the forms. It is a well-known fact that concrete which has been allowed to stand for any length of time, or has been transported any considerable distance in buckets or cars, has a tendency to unmix and is consequently harder to work besides giving inferior results. In order to overcome this tendency, portable mixers were adopted which were moved from place to place, the concrete, in nearly every instance, being discharged, through chutes, from the mixers directly into the forms. Whenever this was impossible, as in the case of a long thin wall, the mixer was set at some convenient place and the concrete transported in two-wheeled buggies.

Occasions have arisen to observe the ability of concrete mixed as above described to withstand water. As Mr. Oestreich has stated, on the above mentioned subway stations no bituminous water-proofing was used below the floor or outside of the walls, dependence being placed entirely on the steel reinforcement and the quality of the concrete (see Plate 68). In places the floors are called upon to withstand outside water under a head of 20 ft., and no pronounced leaks have occurred, though sweatings and small weepings at the junctions of successive day's work have been noted. At one point in one of the depressed tracks south of Thirty-eighth Street a very wet bottom was encountered and no expedient, other than placing the first layer of concrete in water, was found, it was deemed advisable to insert water-proofing material in the concrete. Hydrated lime was selected and used to the amount of 10% of the cement by weight. The lime and cement were thoroughly mixed dry before being placed in the mixer as it was thought that the lime would be more efficacious acting directly on the cement rather than dissipated throughout the aggregate. Highly satisfactory results were obtained as was shown by opening weep pipes which were inserted through the floor to permit the concrete to set. On removing the caps from those pipes the water from underneath spouted five or six feet high, though no leakage was discernible through the floor.

The general method of procedure in ground of this character, when water is entering the trench from sides and bottom, is to establish pump sumps, wherever possible, at the lowest point and outside the line of construction, even though additional excavation

is required. Terra cotta drains, laid with open joints in ditches excavated below the subgrades, lead to the sump wherever water is encountered. These pipes are covered with gravel which permits water to enter at any point, thus keeping the bottom dry. Sumps located in this manner can be pumped continuously without interfering with construction, and do not require sealing when the work is done.

Very little time was lost in concrete work because of cold weather. When the first cold approached, methods for heating concrete aggregates were considered, but no feasible means of heating a sufficient quantity—about 200 cubic yards per day—could be fixed upon. A better plan was thought to lie in heating the water, taking into consideration the relative values of the specific heat of water and silicious material. Some old upright hoisting engine boilers were pressed into service, mounted on trucks so that they could easily be moved about, and the experiment tried of connecting them to the water mains and the mixers in a manner similar to a kitchen tank, the boiler acting as a reservoir in which the water was heated in transit from main to main. In this manner it was hoped to keep the water at a temperature sufficient to heat the whole mass enough to allow the concrete to attain its initial set before freezing. The experiment was more than successful. Coal for fuel was at first used and great care was needed to keep the boilers from steaming. Afterwards no fuel but wood was used and no trouble was found in maintaining a temperature of 150° F. in the water, even when the mixers were running full blast. It was not deemed advisable to raise the temperature of the water above 150° for fear of flashing the cement. On days when the thermometer registered as low as 20°, with none of the material heated, concrete was regularly discharged from the mixers into the forms at 55°.

JOSEPH HUNT, M. M. E. N. Y.—The novel piece of sewer work on Contract 11-A-3, referred to by Mr. Oestreich, was due to the enlargement of a portion of the trunk sewer in Third Avenue (one block west of the subway), between Twenty-sixth and Twenty-seventh Streets.

The old longitudinal sewers on the east side of Fourth Avenue originally ran north and south to Twenty-seventh Street and westward through Twenty-seventh Street to Third Avenue. Construction details made it impractical to have a sewer crossing under the subway at Twenty-seventh Street and made it desirable to locate it at Twenty-sixth Street. This necessitated the construction of an off-line sewer in Twenty-sixth Street to Third Avenue, and the reconstruction of the Third Avenue sewer between Twenty-sixth and Twenty-seventh Streets, above mentioned.

This work was of unusual character and proved very interesting. The original sewer was of horseshoe section, 6 ft. 9 in. high and 8 ft. 6 in. wide, increasing to a larger size of similar section at Twenty-seventh Street. The original plan called for the entire removal of this sewer and the substitution of a new concrete horseshoe section 7 ft. high by 13 ft. 8 in. wide, at the same grade as the old sewer. A survey of the existing conditions proved this to be a most difficult task. The avenue is only 42 ft. wide between curbs and contains a two-track overhead trolley line. The trucking traffic was very heavy, due to the shipping and factory interests in the vicinity, and being diverted also from Fourth Avenue on account of the subway construction; the old sewer carried a large dry weather flow which could not be advantageously flumed on account of the restricted working space, so the writer suggested the construction of a rectangular section 7 ft. high by 13 ft. 8 in. wide with the side walls entirely outside of the old sewer which were to be built without disturbing the flow and afterward incorporating the old invert as part of the new section (see Plate 80, Fig. 1). This plan received the approval of the contractor and the Public Service Commission and proved a most satisfactory solution of the difficulty. The old sewer had an 8-in. brick invert and side walls laid in a rubble cradle, and a 12-in. brick arch also backed with rubble masonry, the structure being supported on an 8-in. timber foundation. An examination of the interior of this sewer showed it to be in excellent condition, and two test pits sunk adjacent to the work exposed sand, gravel and clay with little water, though subgrade was 2½ ft. below mean high-water, and showed the timber foundation to be as sound as when first laid. As the sewer lay directly beneath the car tracks, the first step was the removal of same and the substitution of a temporary single track on one side of the street to which the cars were switched in both directions. This work was done by the railroad company at the contractor's expense. All other traffic was confined to the opposite side of street, a mounted officer being assigned to regulate travel in one direction at a time, as there was not enough room for two vehicles to pass. By referring to the sketch it will be seen that the side walls of the new section are 2 ft. thick, except at the base where they flare out another foot to provide a spread foundation. Two-inch tongued and grooved sheathing was driven to the neat lines of the walls and the banks at the bottom of the sheathing undermined in short sections for the footings. Excavation was then carried to completion leaving the old sewer intact, cutting out only such masonry as was required for the base of the side walls. As the excavation progressed the side walls

were built to their full height, leaving a key in the top of wall to enlarge the roof slab. The sheathing served as one form for the walls.

The next operation was the removal of the old arch and side walls and the bonding of the old invert to the new side walls. The old arch was broken out by means of jacks blocked up from the invert. A Lidgerwood cableway extending the full length of the work was used for the excavation and also for removing the old masonry which was broken out in good-sized sections. The most difficult portion of the work was the completion of the invert out to the side walls of the new section. This was accomplished by building along the center line of the sewer a cofferdam 3 ft. high of two rows of 2-in. tongue and grooved planking laid horizontally, spaced about 10 in. apart and filled with clay. This dam was made secure to the upper braces to guard it against sliding. By means of sand-bag dams built at both ends of a 50-ft. section the entire flow was diverted to one side and the water pumped out of the pocket formed on the other side of the cofferdam. Any portions of the old side walls left standing were then cut out and the bottom cleaned to receive the concrete. It was then a simple matter to complete the invert out to the side walls. When the concrete was thoroughly set, the sand-bag dams were removed and rebuilt on the opposite side of the sewer and the other half of the section completed in like manner. This process followed throughout, the cofferdam being moved along after each 50-ft. length was completed.

The placing of the arch presented no difficulty and was done in the usual manner. Gravel concrete was used throughout in the proportion of $1:2\frac{1}{2}:4\frac{1}{2}$ mixed and placed by hand. The work was carried on expeditiously with a minimum interruption to traffic and at a considerable saving in the cost.

H. L. OESTREICH, M. M. E. N. Y.—Referring to Mr. Purdy's discussion, in which he speaks of the omission of mastic waterproofing and the substitution therefor of a denser concrete with reinforcements, it may be said that it is questionable whether it is wise to use this method in the thin slabs of which subway floors and walls are usually constructed.

It is an established fact that concrete of small size slabs can be made waterproof, but the floors and lower portions of the side walls of subways are below water for distances of thousands of feet. The writer knows of no method by which such a long stretch of concrete can be placed without developing shrinkage cracks.

The Tide Water Company placed concrete roof-slabs at one operation 60 ft. wide and 80 ft. long. There was comparatively little longitudinal reinforcing steel in these slabs, yet each slab

was water-tight in itself. It was at the junction of two slabs where the leakage occurred.

On Contracts 11-A-2 and 11-A-4, under Mr. Purdy's direction, the floor-slabs of reinforced concrete were placed in lengths of 32 ft. without any post-holes through them. A proper length of rods was always permitted to project through the end bulkheads; a bond-piece was always inserted at the end, and great care was taken in scrubbing and washing down the end of the slab before the concrete for the adjoining slab was poured from the mixer to the forms. The materials were always of the best, and at no time did frozen material or concrete affected in any other manner pass into the work.

It should be remembered that the contractor had suggested this method of making the tunnel waterproof and that he had his reputation at stake. The writer does not under-estimate the excellent work done by the Junior Engineers and Inspectors of the Public Service Commission, but no amount of inspection, no matter how carefully done, could have made this job as nearly waterproof as it is, if it had not been for the conscientious and painstaking co-operation of the contractor and all his foremen.

Should the city, however, specify work done in a similar manner, the contractor doing the work would not feel the same responsibility but would rather place it upon the inspectors, and in the event of failure, would probably give as an excuse that the method employed was very unusual.

In conclusion, the writer would say that the work done in this manner by the E. E. Smith Contracting Co. was a very praiseworthy piece of work, but such as it would not be wise to try to repeat on city work.

THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.

Paper No. 76.

PRESENTED NOVEMBER 27, 1912.

A HISTORY OF THE TAXATION OF REAL ESTATE AND THE TAX MAPS OF THE CITY OF NEW YORK.

BY HENRY W. VOGEL,* M. M. E. N. Y.

WITH DISCUSSION BY
WILLIAM F. JOHNES, SIDNEY W. HOAG, JR., AMOS L. SCHAEFFER
AND HENRY W. VOGEL.

Taxation is the compulsory contribution of private income or wealth to the public funds to meet the expenses of government which are for the common benefit.

Alexander Hamilton says: "There is no part of the administration of government that requires extensive information and a thorough knowledge of the principles of political economy so much as the business of taxation."

The expression "transportation is civilization," used by Kipling in one of his short stories, can well be changed to "taxation is civilization." The development and use of the physical and mental abilities of an individual depend upon the extent to which such abilities can safely be taxed; similarly, the effectiveness and progress of municipal corporations depend largely upon the money that can justly be raised by taxation for legitimate purposes.

When a community and its expenses are small, and the income of the families is common knowledge, the problem of taxation is very simple. But where real estate bears the brunt of taxation, where the community is very large and cosmopolitan, and when the tax on real estate amounts to anywhere from one-fifth to one-half of the income derived from real estate and is increasing at a more rapid

* Surveyor, Department of Taxes and Assessments.

rate than the population, it is absolutely necessary that scientific methods should be employed in levying the tax. The first essential to an accurate assessment of real estate is a map showing dimensions and relative locations.

Commercial activities began on the Island of Manhattan in 1610 with fur trading betwen the Holland merchants and the Manhattan Indians. In 1613 two forts were erected for the protection of the fur trade. In 1614 a commercial grant was given to the United New Netherland Company, which expired in 1618; in the latter year a treaty was made between the Dutch and the Iroquois, consisting of five tribes, the Mohawks, Oneidas, Onondagas, Cayugas and Senecas.

The Dutch West India Company was chartered June 3d, 1621, modelled after the celebrated East India Company, with which body it was designed to co-operate in "extending national commerce, in promoting colonization, in crushing piracy, but above all, in humbling the pride and might of Spain," with which country Holland was then at war. The managers of the new company were called the Lords Directors.

Peter Minuit was appointed Director-General of New Netherlands in 1624, with a council of five he governed the colony.

Manhattan Island was purchased from the Indians in 1626 for 60 guilders ($24). In that year 8 130 beaver skins, valued at $19 000, were exported, the estimated value of the imports was $8 500.

The trade of the colony was for many years monopolized by the Dutch West India Company. Smith, in his "Wealth of Nations," says: "The government of an exclusive mercantile company is the worst of all governments for any country, so colonies can never be fostered or promoted by the commercial monopolies of such privileged associations." The company ruled the colony only with a view to promote its own special interests.

In 1638, the States General, the legislative body of Holland, became deeply interested in the advancement of New Netherlands, and desired to adopt a plan for the encouragement of a sound and moral emigration. The monopoly of the New Netherland trade which the West India Company enjoyed was abolished; the trade as well as the cultivation of the soil thrown open to every person, whether native or foreigner, who chose to embark in it, subject to the following conditions: An import and export duty of 10 and 15%,

PLATE 95.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
VOGEL ON
HISTORY OF TAXATION OF REAL ESTATE
AND TAX MAPS OF THE CITY OF NEW YORK.

THIS MAP, COMMONLY KNOWN AS THE RATZER MAP, SHOWS IN PART THE LANDS UNDER WATER INCLUDED IN EACH WARD.

respectively, on all merchandise, payable to the West India Company; land to be free for cultivation for 10 years, after which 10% of the produce should be paid to the same company.

New Amsterdam was incorporated as a city in 1652. Its charter gave nothing excepting a court of municipal magistrates, a Schout, two Burgomasters and five Schepens, with certain judicial functions, and vested in the two Burgomasters the general regulation of the city improvements. No grants of franchises or property were made out of which a municipal fund could be derived. The West India Company, a trading institution, remained the supreme proprietary and governmental power.

The principal expense of the city at this time was the cost and maintenance of defenses. To meet this expense the government permitted the city authorities to retain the excise on beer and liquors which had heretofore been a perquisite of the West India Company. This excise was a source of considerable revenue. Beer was the usual beverage at table, and supplied the place of tea and coffee of the present day.

Financial embarrassments of the city authorities existed during the whole of the period that the Dutch authority was maintained. The Burgomasters brought the matter to the attention of the Lords Directors of the West India Company in the Fatherland, and were from time to time granted various concessions. They also applied in 1658 to the Director-General of the colony, Peter Stuyvesant, for the proceeds of the weigh scales. He answers them and enumerates the various grants and concessions to the city, as follows:

1st—An assessment on the inhabitants of 6 000 florins ($2 400), which was to defray expenses of the last attack by the Indians.

2d—A Burgher's excise on wine and beer, which was farmed last year for 4 200 florins; this year for 3 700 florins.

3d—A duty on slaughtered cattle, farmed last year for 720 florins; this year for 1 457 florins.

4th—A tapster's license at one pound flemish ($2.40) per quarter from each tapster.

5th—The stamping of all measures, cans, barrels and weights.

6th—A grant of the unsold lots within the city wall.

7th—The great and small burgher recht (the fees for making citizens of different grades).

8th—A loan for the repair of the canal, 1 000 guilders ($400).

9th—The privilege of collecting a beaver for each house in the city, and a guilder yearly for each chimney, to support the fire apparatus.

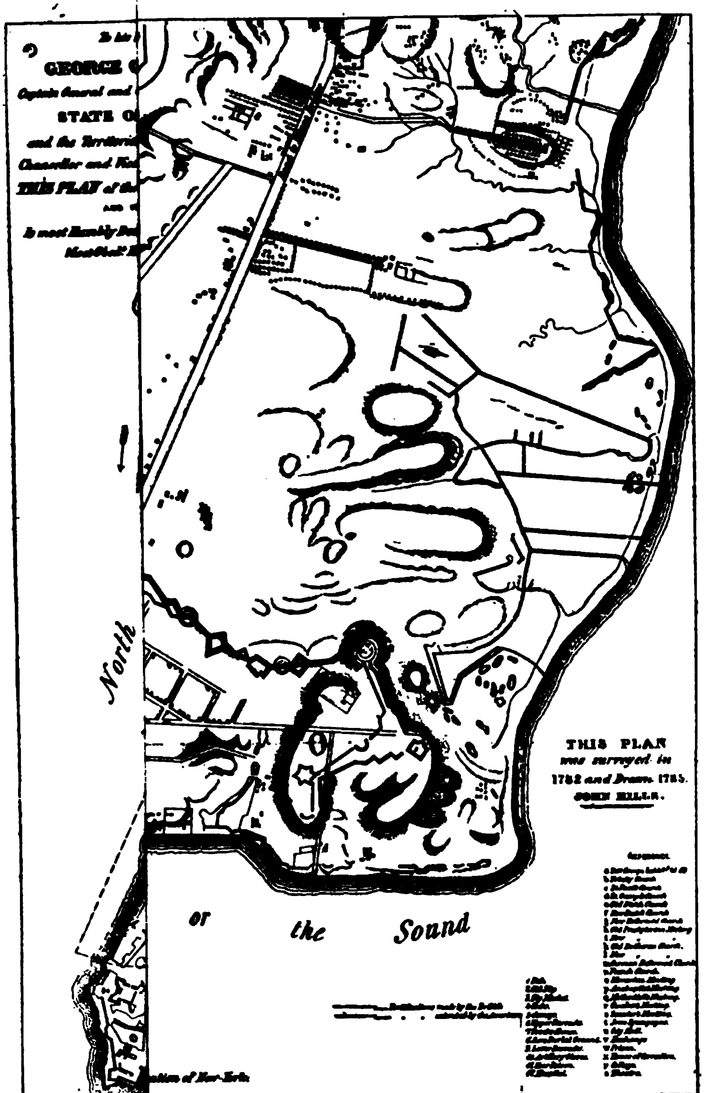
10th—A tax on vacant lots.

"However, that the city may at once be relieved of old and new debts, he consents that a fourth part of the proceeds of the weigh scales shall be paid to the city, and hereafter, if additional revenue be required, no demand shall be made of the general government, but the commonalty shall be made to pay."

The taxation, or rather the freedom from taxation, of real estate is shown by the following ordinance of New Amsterdam which was adopted January 15, 1658:

"The Director-General and Council daily see, that their former well-meant orders and proclamations are not obeyed, but that notwithstanding their repeated renewals many fine and large lots in the best and most convenient parts of this City remain unimproved and are kept vacant by their owners, either for a profitable advance in price or for pleasure, preventing others from building and thereby increasing the population of the City, from promoting our trade and from beautifying this place, which to do, many newcomers might be induced, if they could buy a convenient lot for a reasonable price, conform to the above-mentioned ordinances. The neglect, if not villification, thereof principally leads to the keeping back these large and fine lots for profit or pleasure and this is done, because the former ordinances do not carry a fine; for the owners who have held such lots for years without expenses, are keeping them for an advance in price, or using them for pleasure as orchards or gardens, thereby preventing the erection of houses and the increase of the population, hence also the advancement of trade and injuring the well being of the City, contrary to the good intention of the Lords Directors of the West India Company, the Masters and Patroons of this Province, as first givers and dispensers of the lots, to be used for the adornment, population, increase of inhabitants, trade and welfare of the City by houses, as the patents given expressly stipulate, under such taxes, as said Lords or their deputies may impose. In obedience to their orders the said Director-General and Council have lately caused their sworn surveyor, in the presence of the Burgomasters to survey and measure the vacant lots for regulating the streets and they find several hundred lots within the City walls vacant and not built on. In order that, agreea-

PLATE 96.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
VOGEL ON
HISTORY OF TAXATION OF REAL ESTATE
AND TAX MAPS OF THE CITY OF NEW YORK.



THE [...]E OF DECEMBER 8TH, 1683. THE MONTGOMERY WARD
[...]NTGOMERY CHARTER.

bly to the good intentions of the said Lord Director and in conformity with the former ordinances, these may the sooner be built upon, any way, that the doubts about the ownership of such large lots for profit or pleasure without taxation may be settled and the persons, wishing to build on lots, acquired at a reasonable price, may be accommodated, the Director-General and Council amplifying the former ordinances ordain that all vacant lots lately measured and laid out by the Surveyor of the Director-General and Council, shall immediately after publication hereof be appraised and taxed, first by the owners themselves, that they may not complain hereafter over the valuation by others, which appraisal shall stand as long as the owner keeps the lot or lots unimproved, he paying his yearly tax of the 15th penny in two instalments, namely, one-half on Mayday, the other before the Fairday of this City; this revenue is to be applied to the fortifications of this City and their repairs. The Burgomasters are directed and authorized, to summon after the publication of these presents before them in the City hall the owners of the lots in person, without regard to their position, and have them make the appraisal, which their Secretary is properly to record and the Treasurer is to receive the revenue. In case of opposition or refusal they are civilly to reprove the refractory person and tax his lot according to value and circumstances, under condition that the owner shall have the choice of keeping the lot, taxed by the Burgomasters, if he will pay as aforesaid the 15th penny, or if surrendering it to them for the behoof of the City at the price put on it by the Burgomasters; while on the other side, it is left to the device of the Burgomasters, either to take the lot at its owner's price for account of the City and sell it at this price to any one who desires and is ready to build, conform to the ordinances, or else to leave it to the owner, until it is built upon by him or others, when this burden, for good reasons laid upon unimproved lots, shall be taken off."

The English obtained possession of the colony in 1664, when a Mayor, Aldermen and Sheriff were appointed, with full power to rule and govern all the inhabitants of the city, and corporation and all strangers.

The policy exhibited by the English Government towards the city was of an unusually liberal character, and tended in a great degree to reconcile the Dutch inhabitants to the change of rulers.

In the year 1677 the city debt amounted to 160 pounds sterling, which was cleared off in that year in accordance with an ordinance recorded in the minutes of the Common Council, which reads, in part, as follows:

"A rate of taxation made this 24th day of July, 1677, by the Mayor and Aldermen upon houses and vacant lands within the City for defraying and discharging the City debts and expenses to be paid as follows: the one half thereof immediately and the other half on the 25th of September next following." Then follows a list of about 500 names of owners arranged according to the streets on which the property is located, the property on each street being divided into two classes, the one designated "Houses" and the other "Vacant Places." Occasionally the dimensions or some description is given after the name of the owner; for example, "Derrick Smiths old house against Mr. Lewis 27 foot to ye water 64 foot long wide behind 37 foot," and "Ephraim Harman on ye hill downe to Mother Dobson's front 16 by 60 foot deep" and one more, "Widow Goverts between her two sons houses 25 foot front to ye water 190 foot long." The individual amounts taxed vary from a minimum of two shillings to a maximum of one pound and twelve shillings. At the end of the list is the date 25th of August, 1677, Warrant made to Peter Stoutenberg, Treasurer, to levy the above said sums.

An ordinance of December 8, 1683, divided the city into six wards: North, South, East, West, Dock and Out wards. The Out ward was subsequently divided into two parts, the Bowery division and the Harlem division. The Montgomery charter added an additional ward called the Montgomery ward.

An ordinance of December 10, 1683, provided for the election of two Assessors and one Collector for each ward.

On August 24, 1685, the Common Council "Resolved that it be given to the respective assessors in the several wards of this City, to make a valuation of the estates of the several inhabitants within their said wards both householders and strangers, and therein to express what houses or lands belong to each particular person and their value and what value their personal estates are and make return thereof to the Mayor on or before Saturday the fifth of September next ensuing. On the 7th of September, 1685, the assessors having returned the valuation of the houses, lands and personal estates within their several wards, ordered, that Mr. Alderman Bayard, Mr. Alderman Lawrence, Mr. Debryne and Mr. Merritt do examine the valuations made by the assessors and see where they

A Tax List of the West Ward of the City of New York by Simon V. Antwerp & Wm. G. Forbes		Real	Pers.
Archibald Kennedy Lr	Broadway	2500	
Spanish Ambassador Tn	Do	—	—
John Mallett Lr		2000	
Wm Smith Member of Congress in Do			
Robt Livingston Esqr L		2500	
Do Do			1000
John Stevens Empty L		1100	
Elizabeth Vancortlandt L		800	
Do in Do			600
John Vancortlandt Tn Do			100
Eve White L		800	
Do Do Tn Do			600
John Alsop L		200	
Thos Ellison unfinished hr		400	
Augustus Vancortlandt L		1250	
Henry White Tn Do			750
Augustus Van Cortlandt		250	
Gerret Heyer In Do			
Thos Marston Lo		1300	
John Mansfield In Do			325
Mary Shann L		600	
Benjamin Greaves In Do			
Elizabeth Alstine L		330	
Danl Mack In Do		—	
Mary Shann L		60	
Wm Warlin In Do		—	
Mary Shann L		100	
Peter Lowry			
Jeremiah Oliver unfind		30	
Augustus Vancortlandt Stable Occupied by Henry White		120	
John Fozine N Lott		40	
Mary Shann Do Do		40	
		14420	3375

PLATE 97.—TAX LIST OF THE WEST WARD FOR THE YEAR 1789, COMPLYING WITH CHAPTER 67 OF THE LAWS OF 1788. THE VALUATIONS ARE GIVEN IN POUNDS.

over valued to abate, and if under to add, and that all be proportionally done and make their reports on Saturday next in Common Council."

On September 12, 1685, the assessors in the Dock ward having brought in an unequal and unproportionable valuation of the estates of the inhabitants there, ordered, that they do amend the same between this and Monday next and make it proportionable with the valuations in the other wards, under the penalty of five pounds forfeiture.

The charter of 1686, commonly called the Dongan Charter, contained very liberal grants of rights, estates and franchises. By it the corporation became vested in sources of immediate income which went far to defray all the expenses of municipal government. The grants and franchises were of a character that increased in value with the progress of the city.

A few of the important grants contained in the Dongan Charter are:

1st—A general confirmation of all former rights and privileges.

2nd—A specific grant of the City Hall, the two market houses, the bridge into the dock, the great dock (this was at that time the only dock in the city. It extended from the present Broad to Whitehall Street, on the East River) and the ferry (at Peck Slip).

3rd—All the waste, vacant, unpatented and unappropriated lands on Manhattan Island, reaching to low-water mark, together with the rivers, rivulets, coves, creeks, pond waters and water courses not before granted.

4th—The power to grant licenses to tavern keepers and all sellers of any sort of liquors at retail.

5th—To make free citizens, who alone should be privileged to carry on any "art, trade, mystery, or manual occupation" within the city.

It may be proper to refer here to the method of defraying the cost of various necessities which in modern times are largely paid for by general taxation.

The paving of streets, by ordinance of 1685, was done by each owner in front of his own premises.

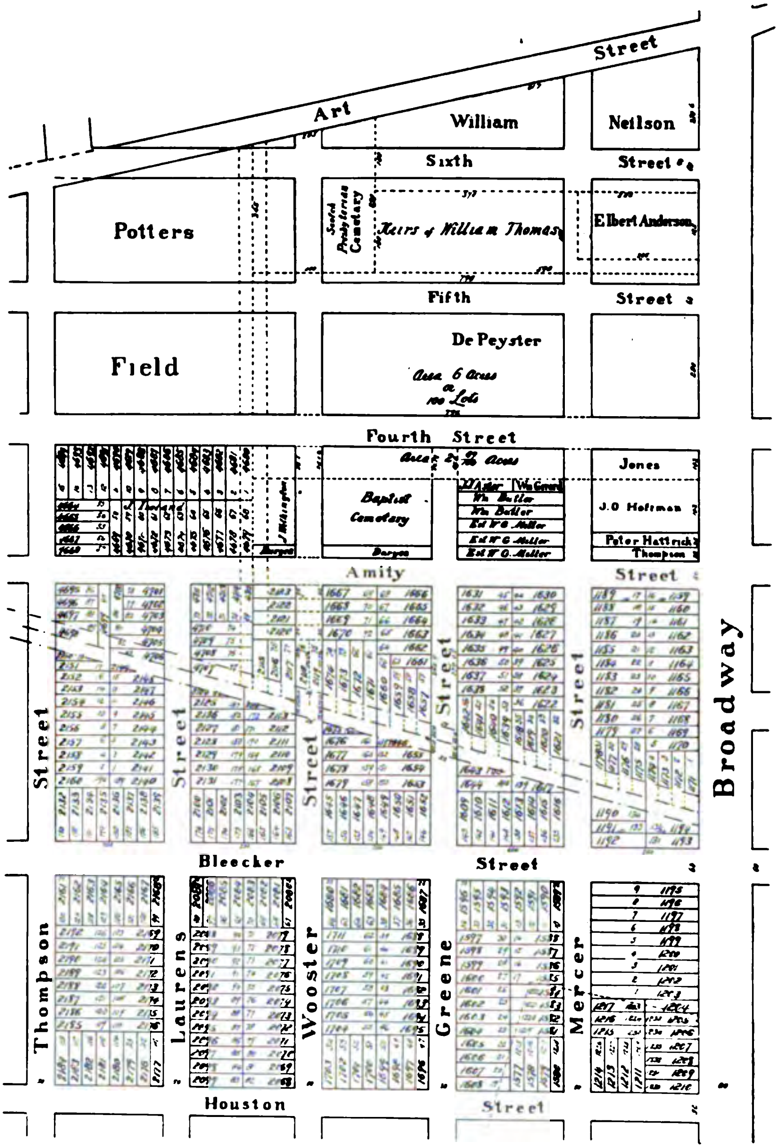


PLATE 98.—MAP OF PART OF THE 8TH WARD IN 1815. THE LARGE NUMBERS ON THE LOTS INDICATE THE WARD NUMBERS AND THE SMALL NUMBERS ARE THE LOT NUMBERS ON FILED PROPERTY MAPS. THE PLOT MARKED "POTTERS FIELD" IS NOW WASHINGTON SQUARE.

The inhabitants within a certain district were compelled to contribute for the construction of public wells.

For the support of the poor, an ordinance of 1688 required the alderman of each ward to send his constable around the ward to inquire for persons who needed relief. The funds for relief came in part from charitable donations to the poor's box in the church, and in part from the city treasury.

An ordinance of 1691 required all persons on every Saturday (season permitting) to sweep the dirt in the streets before their houses into heaps, and load the same into carts, or else pay the cartman 3 pence for loading the same. The cartmen were required, as a condition of their license, to cart this dirt away.

The power to levy a public tax, either for general or specific purposes, did not vest in the municipal corporation under any of its early charters; it probably could not be conferred by the crown alone, being the highest exercise of sovereign authority, but only by parliament or the state.

A study of the colonial laws between the years 1664 and 1775 shows that two well-defined agencies were created and developed by the colonial legislature for levying taxes, the one for a general colonial tax, levied by assessors, the other a tax for local purposes in the subdivisions of the colony, levied by vestrymen.

An act of October 2, 1690, is the first general tax law of the colony, it is entitled: "An act for raising three pence in the pound of all real and personal visible estate of all and singular the inhabitants of this province, one-half thereof to be paid at or before the 21st of January next ensuing, and that assessors and collectors for executing of said act be chosen by the freeholders of each town within this province." In the City of New York two assessors and one collector were chosen for each ward.

A law of 1758, entitled "An act to regulate the taxing of real and personal estates in the City and County of New York," contains the following: "Whereas the method now used in the City and County of New York in taxing real and personal estates is found to be uncertain and unequal, Be it enacted by his Honor the Lieutenant-Governor, the Council and General Assembly, and it is hereby enacted by the authority of the same, that all Real Estates in the City and County of New York shall, from and after

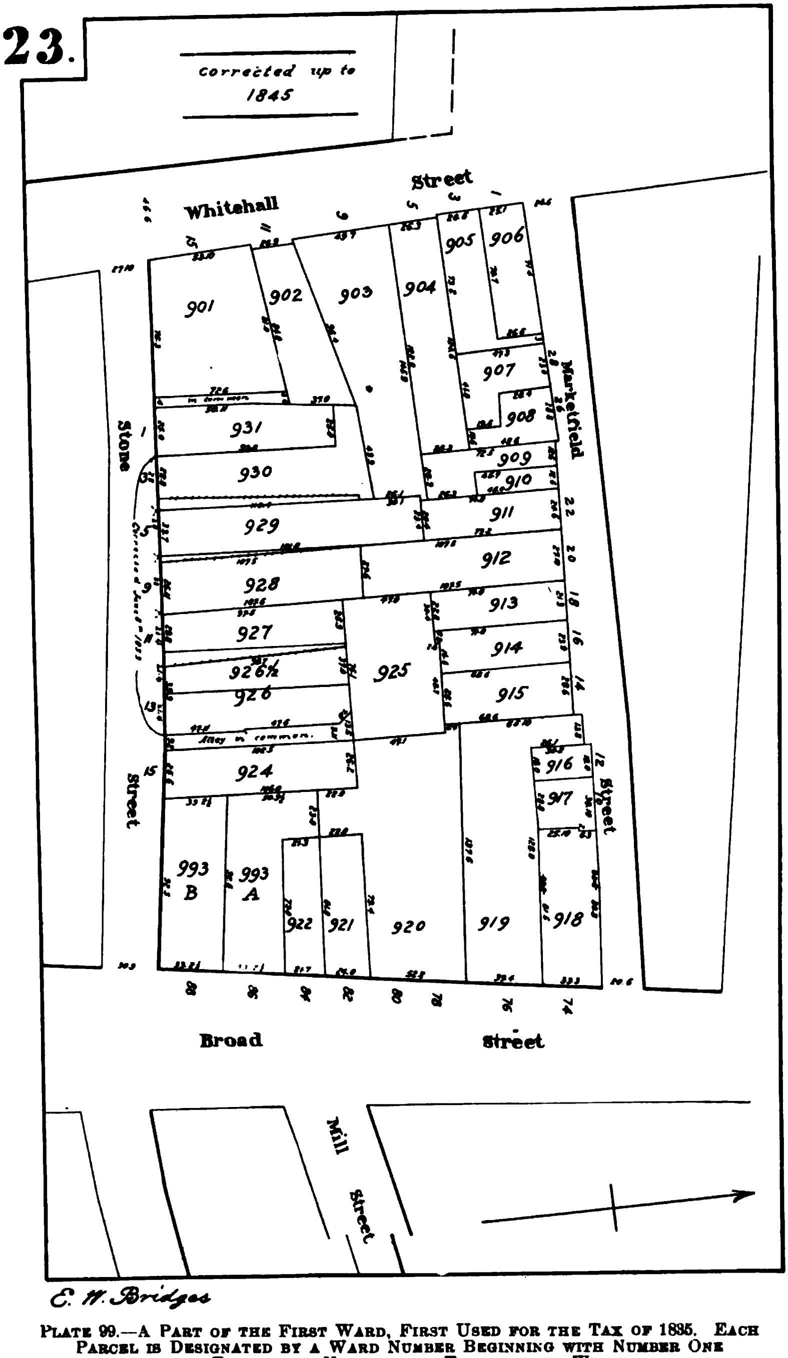


PLATE 99.—A PART OF THE FIRST WARD, FIRST USED FOR THE TAX OF 1835. EACH PARCEL IS DESIGNATED BY A WARD NUMBER BEGINNING WITH NUMBER ONE AND PROCEEDING NUMERICALLY THROUGH THE WARD.

the publication of this act, be rated or assessed at two-thirds part of the rent or yearly income of the same, and if it be occupied by the owner or proprietor shall be assessed on oath in like proportion, according to what the assessor shall judge the true income shall be in case the same were rented out."

The colonial laws relating to taxes for local purposes are very numerous. The first law, passed in 1693, is entitled; "An act for settling a ministry and raising a maintenance for them in the City of New York, County of Richmond, Westchester and Queens County."

After citing the profaneness and licentiousness that hath of late spread over the province for want of a settled ministry, the act provides "For the more orderly raising the respective maintenances for the ministers aforesaid, Be it further enacted by the Governor and Council and representatives convened in general assembly, That the respective Justices of every City and County aforesaid or any two of them shall every year issue out their warrants to the constables to summon the freeholders of every City County and precinct aforesaid together on the 2nd Tuesday of January for the *chusing* of ten *Vistry* men and two church wardens and the said justices and Vistrymen or major part of them are hereby impowered within ten days after the said day or in any day thereafter as to them shall seem convenient to lay a reasonable tax on the respective City County parish or precinct for the maintenance of the minister and poor of their respective places. A roll of the said tax shall be delivered into the hands of the respective constables of the said *Cityes,* County, parishes and precincts with a warrant signed by any two justices of the peace, *impowering* him or them to levy the said tax, and pay the same into the hands of the church wardens retaining to himself 12 pence per pound for levying thereof. The monies or goods to be disbursed by the church wardens for the purposes and intents of this act and not otherwise by orders from the said Justices and Vistry men."

This act was known as the "minister and poor act." In 1745 the act was amended for the City of New York so that there should be two vestrymen for each ward or division of said city, and that the vestrymen so chosen should before making any assessment, meet together and then and there agree among themselves in what pro-

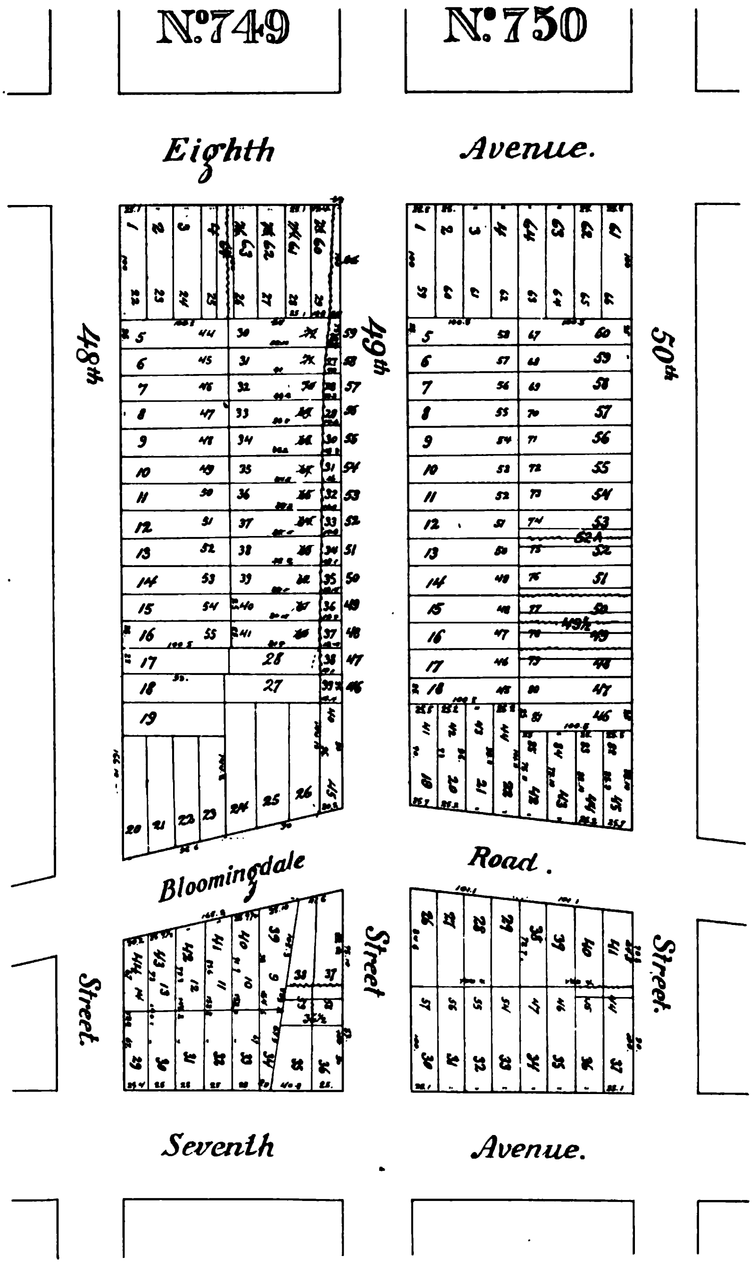


PLATE 100.—A PART OF THE 12TH WARD. NOW THE 22ND WARD. FIRST USED FOR THE TAX OF 1849 THE MAP SHOWS THE FIRST USE OF BLOCK NUMBERS, EACH BLOCK BEGINNING WITH LOT NUMBER ONE. SOUTH OF 40TH STREET NO BLOCK NUMBERS WERE USED UNTIL 1898, WHEN THE BLOCK MAP OF TAXES AND ASSESSMENTS WAS PREPARED.

portion or rule the estates real and personal of the respective inhabitants should be taxed.

Subsequent acts of the colonial legislature authorized and directed the vestrymen and constables at the same time that moneys were raised for the minister and the poor to levy and collect moneys for the following purposes: For providing watchmen and lighting lamps, for keeping in repair the public roads, for raising money towards building a bridewell or workhouse, for finishing the jail, for purchasing Bedlow's Island for a pest-house, for providing firewood, candles, bedding, etc., for his Majesty's forces quartered in the barracks belonging to the City of New York, and for repairing public wells and pumps.

An act of 1770 directed the church wardens to deliver the moneys received by them into the hands of the Chamberlain, to be by him paid as directed by warrant or warrants of the Mayor, Aldermen and Commonalty in Common Council convened.

The first session of the legislature of the State of New York, after the Declaration of Independence, occurred in 1777.

Chapter 62 of the Laws of 1787, directs that taxes for all purposes shall be levied by assessors, collected by collectors and paid into the hands of the treasurer or chamberlain.

Chapter 67 of the Laws of 1788, entitled "An act for the more effectual collection of taxes in the City and County of New York," directs that the assessors between the 15th of May and 5th of July in each year shall fix the value of real and personal estate of every freeholder, inhabitant and resident within their respective wards, making a list which shall show the owners' names, and opposite the names the value of the real estate in one column, the personal estate in a second column, leaving a third column in which to insert the sum each person is to pay. Each assessor shall complete and sign his list, and deliver it to the Mayor, Recorder and Aldermen of the city, on or before the first Monday in July. The Mayor, Recorder and Aldermen shall then fix a rate and cause computation to be made of the amount to be paid by each person, and have the amount inserted in the third column, and immediately after the 14th of October cause the list of assessment of each ward so completed to be delivered to the collector of the same ward with a warrant commanding the collector to collect and pay the moneys so

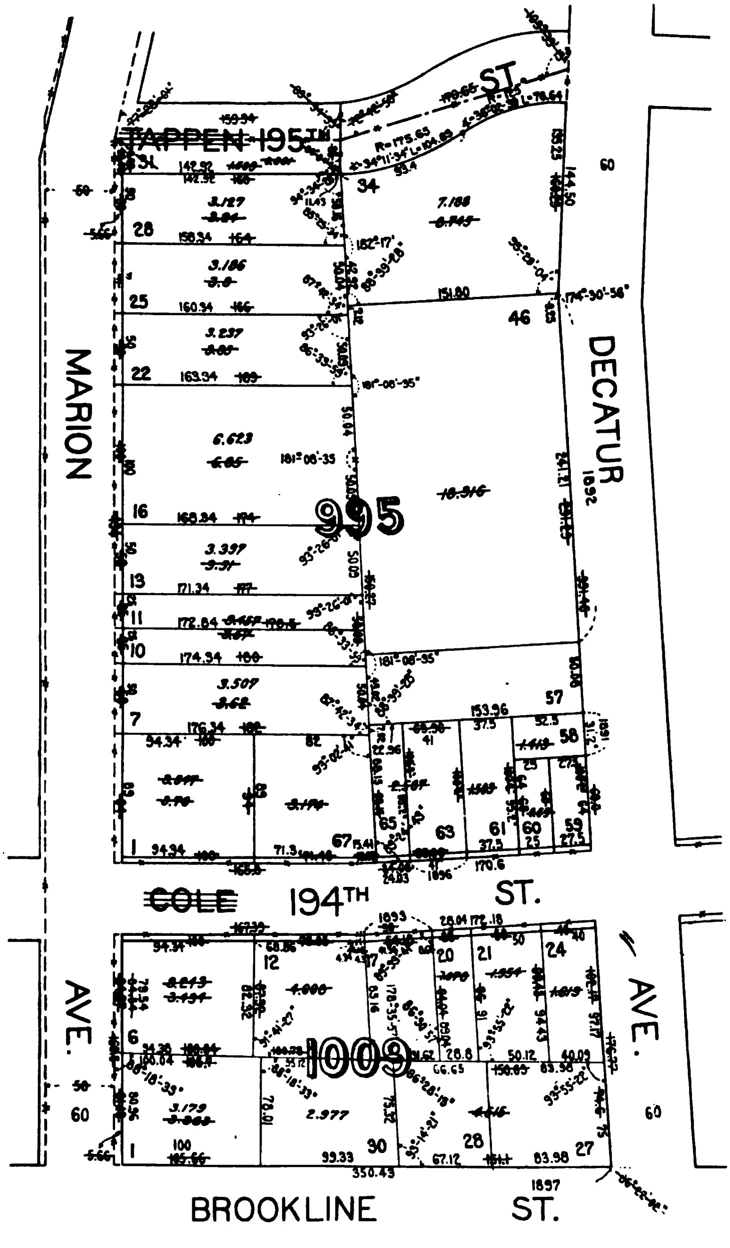


PLATE 101.—A PART OF THE MAP OF THE 24TH WARD PREPARED BY THE DEPARTMENT OF PUBLIC PARKS UNDER CHAPTER 411, LAWS OF 1876.

collected to the treasurer or chamberlain of said city on or before the third Tuesday in February then next.

Chapter 18 of the Laws of 1791 defined the boundaries of the wards and designated them by consecutive numbers from 1 to 7. Subsequently and from time to time the number of the wards was increased and the boundaries were changed.

Chapter 52 of the Laws of 1813, a State tax law, directs that two tax lists shall be prepared, one containing the resident and the other the non-resident taxpayers.

Article 5 of Chapter 272 of the Laws of 1823, provides that all real and personal estate shall be valued by the assessors for the purpose of taxation at the value they would appraise such estate in payment of a *bona fide* debt due from a solvent debtor, and that taxes shall be imposed according to such valuation.

Chapter 121 of the Laws of 1850 created the first board of tax commissioners, consisting of three members appointed by the supervisors. The people continued to elect two ward assessors for each ward, until the positions were abolished by Chapter 677 of the Laws of 1857. This law directed as follows:

"The Commissioners of Taxes and Assessments shall appoint twelve persons, to be known as deputy tax commissioners, who shall perform under their direction and supervision the duties now performed by the assessors of the several wards of said city and such other duties as they shall prescribe.

"It shall be the duty of the deputy tax commissioners, under the direction of the Commissioners of Taxes and Assessments, to assess all the taxable property in the several districts that may be assigned to them for that purpose by said Commissioners, and they shall furnish to them, under oath, a detailed statement of all such property showing that said deputies have personally examined each and every house, building lot, pier or other assessable property, giving the street and *ward map* number of such real estate embraced within said districts, together with the name of the owner or occupant, if known; also, in their judgment, the sum for which such property, under ordinary circumstances, would sell."

Section 9 of this act directs that,

"The said Commissioners shall appoint a surveyor from one of the City Surveyors, whose duty it shall be to make the necessary surveys and corrections of the ward maps, and also all new maps which may be required for the more accurate assessment of real estate."

EAST WILLIAMSBURGH

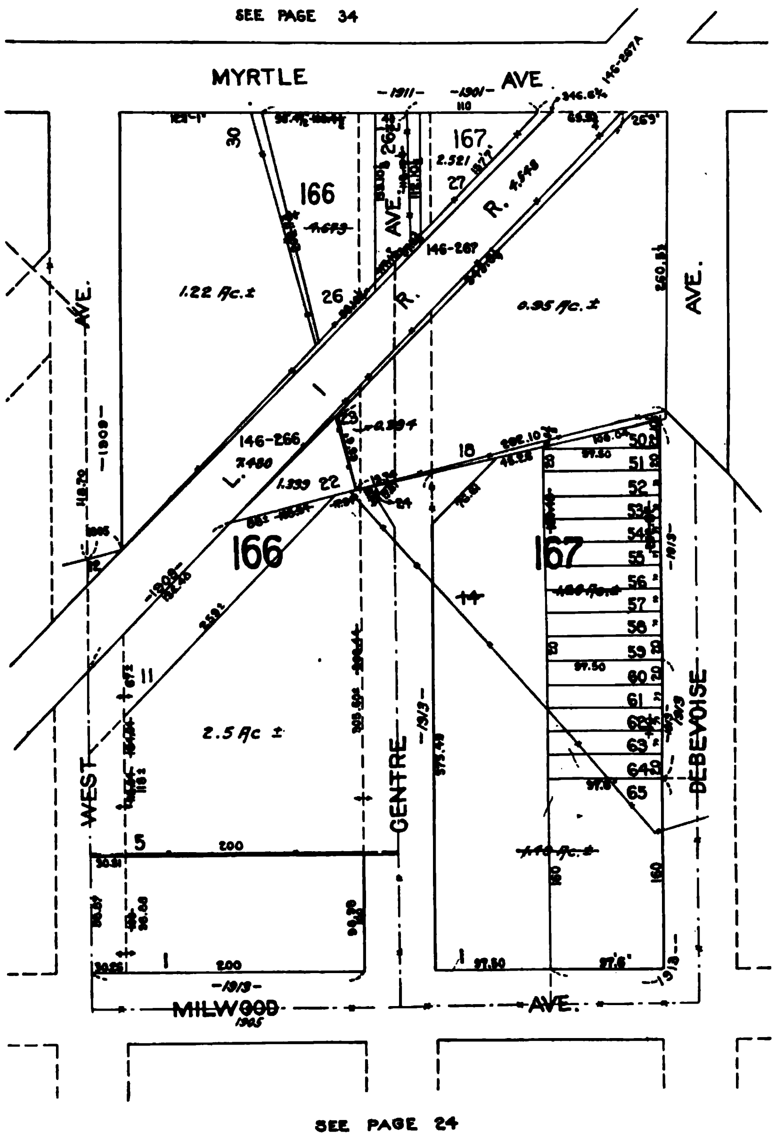


PLATE 102.—TENTATIVE MAP OF A PORTION OF THE 2ND WARD, BOROUGH OF QUEENS, ANNEXED TO THE CITY OF NEW YORK IN 1898.

The methods of taxing real estate set forth in the Law of 1857 have been continued to the present time. This law created the position of surveyor to the Board of Taxes and Assessments and is the first State law in which ward maps are mentioned.

The ward maps, however, are frequently mentioned prior to 1857 in resolutions of the Board of Aldermen and Board of Supervisors. A few instances are here given: On February 16, 1829, the Board of Aldermen Resolved, that the Street Commissioners be directed to have a survey and map made of the second ward, for the purpose of assessing the taxes. On March 17, 1834, Resolved, that the Street Commissioners cause correct maps to be made of the first, third, fourth, fifth, sixth, seventh, eighth, ninth and tenth wards, and of such parts of the twelfth ward as are within the lamp and watch district, and of the thirteenth and fifteenth wards of the city, to be used by the assessors of taxes in the said wards, when in the performance of the duties enjoined upon them by law, and at all other times to be deposited in the office of the Street Commissioner. On the 24th of February, 1845, the Board of Supervisors received the following report from the Comptroller:

"I would respectfully call your attention to the imperfect condition of many of the maps of the various wards, at present used by the assessors.

"The map of the first ward was made in 1835, before the great fire, and the alteration of the lines of many streets consequent thereon, and requires many corrections.

"The map of the second ward was made in 1829. Since that time, Liberty Street, Maiden Lane, John Street, Fulton Street, Ann Street, Spruce Street, Platt Street, and several other streets have been widened, so as to render the present map almost useless and a new one is much wanted."

After describing the maps of the other wards, the Comptroller recommends to the Supervisors the following resolution, which the Supervisors adopted:

"Resolved: That the Comptroller be and he is hereby directed, with the assent of the Committee on Annual Taxes, to cause such renewals and repairs to be made to the maps of the various wards, used by the Assessors, as shall fit them for uses for which they are intended, and that the same be done before the Assessors for the year 1845 commence their duties."

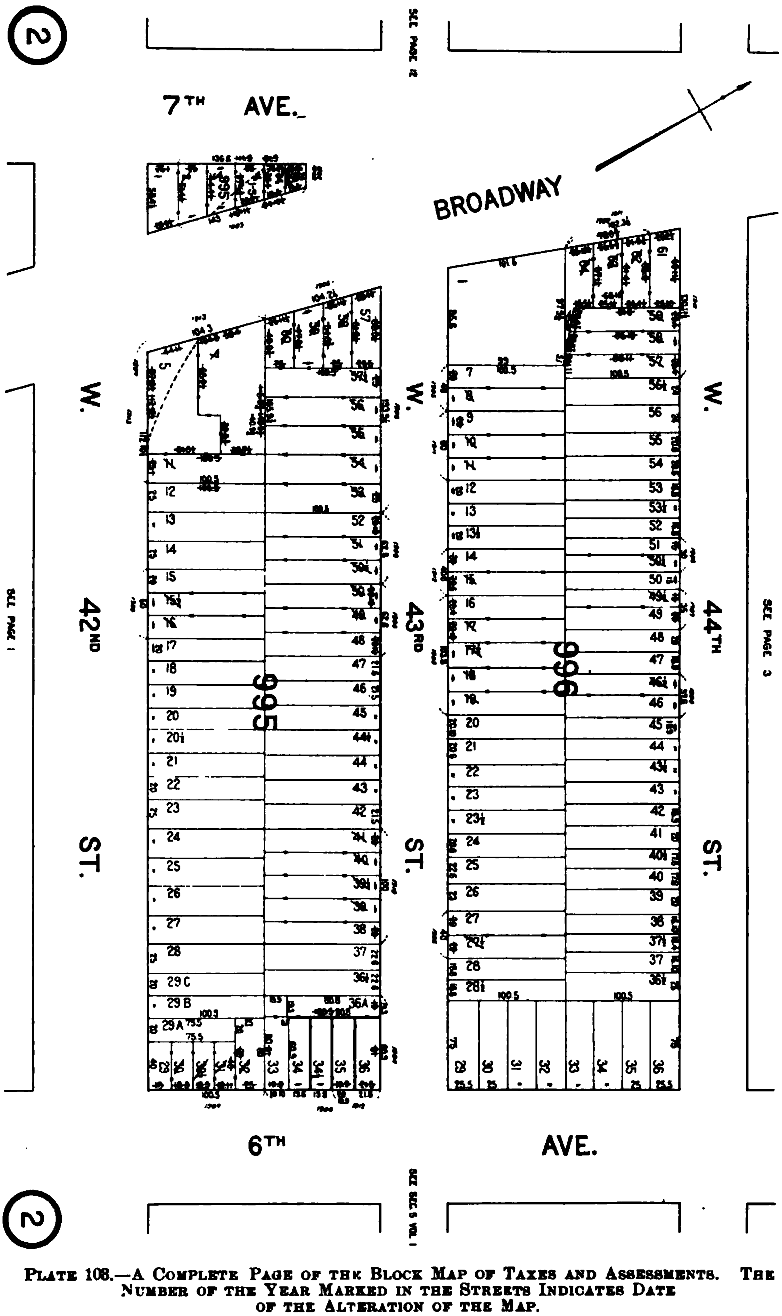


PLATE 108.—A COMPLETE PAGE OF THE BLOCK MAP OF TAXES AND ASSESSMENTS. THE NUMBER OF THE YEAR MARKED IN THE STREETS INDICATES DATE OF THE ALTERATION OF THE MAP.

The ward maps were made, from time to time, by private surveyors. There is no uniformity in the size of the volumes in which the maps are bound, nor in the scale of the maps. There are tax maps of some of the wards now in existence which were made in 1815, subsequent to the map known as the Randall map, authorized by an act of the Legislature of 1807 and filed in 1811. The Randall map shows a street plan for the city south of One Hundred and Fifty-fifth Street.

The Twenty-third and Twenty-fourth Wards.

In 1874, pursuant to the provisions of Chapter 329 of the Laws of 1873, the towns of Kingsbridge, West Farms and Morrisania were annexed to the City of New York, and designated as the Twenty-third and Twenty-fourth Wards, the territory annexed added 20 square miles to and doubled the area of the city.

The topographical surveys, the preparation of street plans, sewerage plans and the construction work in connection with regulating, grading and paving streets and building sewers in this newly annexed territory were under the jurisdiction of the Park Department.

Chapter 411 of the Laws of 1876 provided that the Park Department should prepare the tax maps of the Twenty-third and Twenty-fourth Wards for the use of the Department of Taxes and Assessments. For a number of years after annexation this territory was assessed in accordance with maps which were the private property of an assessor, who had been employed by the former towns, and was retained in the employment of the city. The maps were not accessible to the public.

The maps of the Twenty-third and Twenty-fourth Wards prepared by the Park Department are the first maps for taxation purposes prepared by city officials, and are the best tax maps in the possession of the city. The data used in their preparation consisted of practically an abstract of title of each piece of property obtained by searching the records of the register's office, copies of all the property maps filed in the register's office, abstracts and copies of deeds of water grants obtained at the Secretary of State's office and an actual survey of the property lines on the ground, the survey being based on the lines of the streets and avenues marked on the ground by monuments; the fact that the monumenting of the

streets and avenues preceded the preparation of the tax maps was an aid in accurate work.

The maps were designated by the ward number 23 or 24, and each ward was divided into a suitable number of volumes for convenient use. The volumes contained a title page, an index to the volumes in the ward showing graphically the filed property maps in the volume in question and an index to the map pages. The map pages were 18 by 24 in., drawn to a scale of 80 ft. to an inch, showing block and lot numbers, the dimensions of each plot or lot with its area, and also block dimensions. In 1885 (Chapter 530, Laws of 1885), a law was passed exempting from taxation the land lying in proposed streets; this law was due to the fact that a prior law provided that no compensation would be made in street opening proceedings for buildings or improvements made within the lines of proposed streets and avenues, subsequent to the filing of the maps showing such streets and avenues. This necessitated two areas for each parcel of property affected by a proposed street, one a total or gross area, the other area, exclusive of streets, designated a net area. The law prohibiting improvements in proposed streets was subsequently declared unconstitutional, because it practically took private property without due process of law.

Addition to the Twenty-fourth Ward.

Chapter 934, Laws of 1895, added the Town of Westchester, the Village of Wakefield or South Mount Vernon and portions of the Towns of Eastchester and Pelham to the Twenty-fourth Ward. There were doubts concerning the constitutionality of the law of annexation which were cleared away in August, 1895, and in September the Deputy Tax Commissioners commenced their field work, preparatory to fixing valuations, which, in accordance with law, were to be based on maps.

It was therefore necessary to complete maps for a portion of the territory in less than one month, and for the entire territory, comprising an area of more than 20 square miles, in five months. The data and methods used in the preparation of the maps are similar to those used in preparing the maps of the outlying boroughs annexed to the city in 1898 and will be described later.

ANNUAL RECORD OF ASSESSED VALUATION OF REAL ESTATE, THE CITY OF NEW YORK, 1912. BOROUGH OF MANHATTAN.

SECTION 1 , VOLUME 2 , BLOCK No. 66 .

Between NASSAU & WILLIAM Streets Between LIBERTY ST. & MAIDEN LANE

OWNER OR OCCUPANT	Description of Property: Size of Lot	Description of Property: Size of House	Stories High	Houses on Lot	Street No.	Ward Lot or Map No.	Value of Real Estate Unimproved	Value of Real Estate with Improvements	Corrected Amount	Remarks
F. G. THOMAS	[illegible] x [illegible] IRR.	LOT COVERED	[illegible]	1	[illegible]	1	[illegible],000	[illegible],000		
H. B. ELY ET AL	[illegible] x [illegible] IRR.	LOT COVERED	4-4½	1	[illegible]	2	145,000	1[illegible],000		
H. D. VAN WINKLE ET AL	[illegible] x [illegible] IRR.	LOT COVERED	5	1	[illegible]	3	70,000	[illegible],000		
POWERS AND WEIGHTMAN	[illegible] x 101 IRR.	LOT COVERED	10	1	[illegible]	4	[illegible],000	[illegible],000		
THE FAHYS WATCH CASE CO.	40.10 x 101 IRR.	LOT COVERED	10	1	[illegible]	5	[illegible],000	[illegible],000		
MUTUAL LIFE INSURANCE CO.	[illegible] x [illegible] IRR.	LOT COVERED	5	1	[illegible]	6	[illegible],000	[illegible],000		
MUTUAL LIFE INSURANCE CO.	[illegible] x [illegible] IRR.	LOT COVERED	6	1	48	7	[illegible],000	[illegible],000		
LAWYERS TITLE INSURANCE CO	44.4 x [illegible] IRR.	LOT COVERED	[illegible]	1	44-46	8	475,000	7[illegible],000		
MUTUAL LIFE INSURANCE CO.	[illegible] x [illegible] IRR.	LOT COVERED	6	1	41	9	1[illegible],000	140,000		
MUTUAL LIFE INSURANCE CO.	27 x 78.3 IRR.	LOT COVERED	4	1	43	10	1[illegible],000	1[illegible],000		
MUTUAL LIFE INSURANCE CO.	17.5 x 78.3 IRR.	LOT COVERED	4	1	45	11	1[illegible],000	1[illegible],000		
MUTUAL LIFE INSURANCE CO.	24 x [illegible] IRR.	LOT COVERED	5	1	47-49	12	[illegible],000	[illegible],000		
WILLIAM ZIEGLER	[illegible] x 72.1 IRR.	LOT COVERED	7	1	51	13	[illegible],000	[illegible],000		
WILLIAM ZIEGLER	12.1 x 71.5 IRR.	LOT COVERED	5	1	[illegible]	14	[illegible],000	[illegible],000		
MUTUAL LIFE INSURANCE CO	[illegible] x 114 IRR.	LOT COVERED	5	1	[illegible]	15	[illegible]7,000	[illegible],000		
C. A. SMITH	[illegible] x 46 IRR.	LOT COVERED	5	1	[illegible]	16	150,000	1[illegible],000		
MUTUAL LIFE INSURANCE CO	[illegible] x [illegible] IRR.	LOT COVERED	4	1	[illegible]	17	175,000	1[illegible],000		
MUTUAL LIFE INSURANCE CO.	[illegible] x [illegible] IRR.	LOT COVERED	1-4	1	[illegible]	18	1[illegible],000	1[illegible],000		
MUTUAL LIFE INSURANCE CO	[illegible] x [illegible] IRR.	LOT COVERED	6	1	[illegible]	19	70,000	75,000		
MUTUAL LIFE INSURANCE CO	[illegible] x [illegible] IRR.	LOT COVERED	4-5	1	[illegible]	20	[illegible],000	[illegible],000		
MUTUAL LIFE INSURANCE CO	[illegible] x [illegible] IRR.	LOT COVERED	5	1	[illegible]	21	100,000	1[illegible],000		
MUTUAL LIFE INSURANCE CO.	[illegible] x [illegible] IRR.	LOT COVERED	5	1	40	[illegible]	[illegible],000	1[illegible],000		
J. A. DELAFIELD	21 x [illegible] IRR.	LOT COVERED	4	1	[illegible]	[illegible]	[illegible],000	1[illegible],000		
MUTUAL LIFE INSURANCE CO.	21 x [illegible] IRR.	LOT COVERED	4	1	44	[illegible]	100,000	10[illegible],000		
HARTFORD FIRE INSURANCE CO	[illegible] x [illegible] IRR.	LOT COVERED	5	1	[illegible]	31	[illegible],000	11[illegible],000		

PLATE 104. - COPY OF ANNUAL RECORD FOR BLOCK 66, MANHATTAN, SHOWN ON PLATE No. 105.

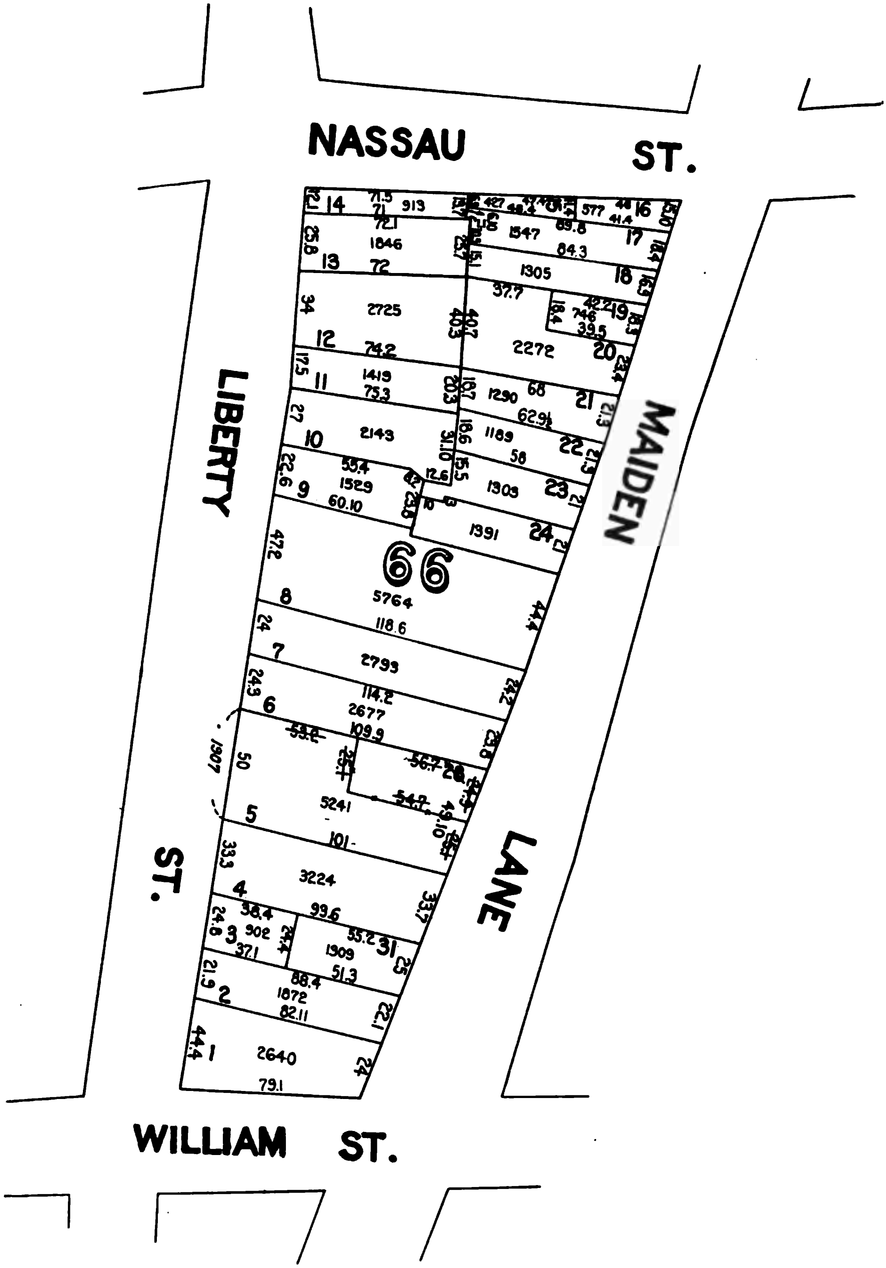


PLATE 105.—BLOCK MAP OF TAXES AND ASSESSMENTS FOR BLOCK 66, MANHATTAN. EACH LOT SHOWS ITS AREA IN SQUARE FEET.

The Block Map of Taxes and Assessments of the City of New York, Chapter 542, Laws of 1892.

This act provides that there shall be prepared, under the direction and supervision of the Commissioners of Taxes and Assessments of the City of New York, a map of the city to be known and designated as "the block map of taxes and assessments of the City of New York," upon which shall be exhibited under sections and section numbers the separate lots or parcels of land shown on such map to be designated thereon by lot numbers, which lot numbers shall correspond as far as may be with the present ward numbers of said lots or parcels, and shall commence in each block with number one, and continue numerically upwards for as many of such lots or parcels as shall be comprised within each block.

When the said block map of taxes and assessments shall be completed the same shall be certified by said Commissioners and shall be filed in their office. Of this map three copies shall be made and certified as aforesaid, one for the use of the deputy tax commissioners of the said Department of Taxes and Assessments, another copy thereof for use in the Bureau of Arrears in the Finance Department of said city, and the other copy thereof for use in the Bureau of the Water Register in the Department of Public Works of said city. The act also provides, that upon the certification and filing of the said maps, the same shall be substituted for use in the office of said Commissioners in place and stead of the map at present in use therein, and also authorizes changes in the lot lines and numbers and the addition of new blocks when necessity may require.

All the sections of the counties of New York and Kings, shown on the land maps of the two counties, are used on the block map of taxes and assessments; where there have been changes in the street system since the filing of the land maps, the block boundaries and numbers on the block map of taxes and assessments do not agree with the land map. Each section is divided into a suitable number of volumes for convenient use, and each volume contains a title page, an index page and an average of 35 map pages. The pages are 14 by 22 in., drawn to a scale of 50 ft. to an inch.

On the ward maps all vacant property south of One Hundred and Fifty-fifth Street had been subdivided into standard lots of

AGGREGATE ASSESSMENTS.

Assessed Valuations of Real and Personal Estate in The City of New York, by Boroughs, Since 1898, Date of Consolidation.

	Manhattan.		The Bronx.		Brooklyn		Queens.		Richmond.		Aggregate.
	Real Estate.	Personal.	Real Estate.	Personal.	Real Estate.	Personal.	Real Estate.	Personal.	Real Estate.	Personal.	
1898	$1,754,982,400	$309,022,449	$101,985,523	$1,731,121	....	....	....	....	....	..	$2,347,325,493
1899	2,054,903,875	483,675,942	123,702,030	6,806,988	$609,822,287	$45,270,713	$103,753,690	$6,314,022	$40,264,692	$3,838,890	3,476,352,029
1900	2,231,902,655	471,861,632	135,494,849	8,613,641	651,408,900	43,937,440	104,427,772	5,498,681	42,723,924	6,264,294	3,654,133,298
1901	2,285,188,713	428,279,951	143,808,303	12,180,607	658,962,119	89,241,624	107,179,620	10,626,810	42,639,305	9,615,620	3,787,970,873
1902	2,330,939,618	412,308,298	153,900,568	12,683,110	670,531,508	85,377,102	108,859,704	9,826,134	38,814,181	6,725,535	3,837,947,718
1903	3,483,793,382	549,843,253	247,090,767	14,762,041	853,760,357	100,052,348	123,781,723	10,176,900	43,124,997	6,031,350	5,432,416,918
1904	3,676,857,411	508,478,655	261,026,477	14,756,958	901,994,952	88,573,775	131,379,225	7,477,425	44,205,709	5,792,070	5,640,542,027
1905	3,820,754,181	568,390,790	274,839,593	16,673,625	940,508,302	90,911,963	140,408,990	9,094,738	44,581,235	5,490,810	5,912,144,227
1906	4,105,352,281	447,184,530	355,779,602	18,025,857	1,072,007,172	87,722,810	159,446,205	9,694,428	45,901,985	4,676,295	6,305,794,185
1907	4,391,970,951	432,654,158	396,687,730	14,115,699	1,181,221,918	92,866,347	217,698,775	11,191,262	52,931,236	4,062,308	6,795,370,473
1908	4,584,536,431	327,810,612	441,228,718	11,539,680	1,334,864,835	83,448,072	296,458,980	9,908,830	65,326,825	3,063,397	7,158,190,400
1909	4,614,446,286	332,202,634	462,704,008	13,990,671	1,354,909,840	84,332,190	308,112,085	9,673,200	67,106,965	3,153,160	7,250,300,539
1910	4,743,916,785	298,030,483	493,757,919	7,716,550	1,404,034,521	59,331,825	334,561,980	5,358,480	67,917,489	2,207,487	7,416,837,499
1911	5,037,872,685	289,797,952	605,222,933	4,946,895	1,689,171,283	55,855,616	446,589,352	5,139,875	88,083,911	1,942,785	8,216,761,287
1912	5,035,485,413	281,467,122	616,521,378	4,995,198	1,674,742,409	48,753,965	456,750,539	6,396,750	78,399,151	1,750,485	8,204,862,430

Aggregate Assessments in The City of New York.

	Real Estate		Personal Estate
1898	$1,856,567,923	1898	$518,757,570
1899	2,032,445,464	1899	545,905,545
1900	3,168,557,700	1900	485,573,558
1901	3,337,776,301	1901	530,192,612
1902	3,332,647,579	1902	526,400,126
1903	4,751,350,829	1903	680,846,892
1904	5,015,463,774	1904	625,678,878
1905	5,221,582,301	1905	690,561,926
1906	5,738,407,245	1906	567,306,949
1907	6,340,488,002	1907	554,500,571
1908	6,722,415,788	1908	435,774,611
1909	6,807,179,704	1909	443,328,855
1910	7,044,192,674	1910	372,644,825
1911	7,858,840,164	1911	357,983,123
1912	7,861,898,890	1912	342,963,540

Table showing Decreasing Percentages in Assessments of Personal Estate.

Year	Real Estate	Personal Estate	Total	Personal Estate's Percentage of Total.
1688			$391,000	
1790			11,700,000	
1826	$64,800,000	$42,400,000	107,200,000	39.5
1850	207,100,000	78,900,000	286,000,000	27.6
1902	3,332,000,000	526,000,000	3,857,000,000	13.6
1903	4,751,800,000	680,800,000	5,432,400,000	12.5
1912	7,861,900,000	343,000,000	8,204,900,000	4.2

PLATE 106.

25 ft. front by 100 ft. (more or less in depth, the depth depending upon the size of the blocks from street to street, which in all the blocks from Fourteenth to One Hundred and Fifty-fifth Street is approximately 200 ft.). On the block map of taxes and assessments an effort was made to show only ownership lines and lines of physical possession. Grants of land under water from the State or city to private individuals were examined and plotted on the maps; on the 28th of September, 1871, the State granted to the city all its riparian rights adjacent to Manhattan Island, and on April 5, 1888, the same rights adjacent to the 23rd and 24th Wards.

Block dimensions are not shown in order to keep the frontages on the streets clear for the dimensions of subdivision alterations, and the year for which an alteration is made. The side lines of proposed streets are shown in dotted lines, the street names in skeleton letters and the land in the proposed street connected with the land on the block by an arrow when both are one ownership; when the street is opened the dotted side line is changed to a solid line and the lettering of the street name filled in.

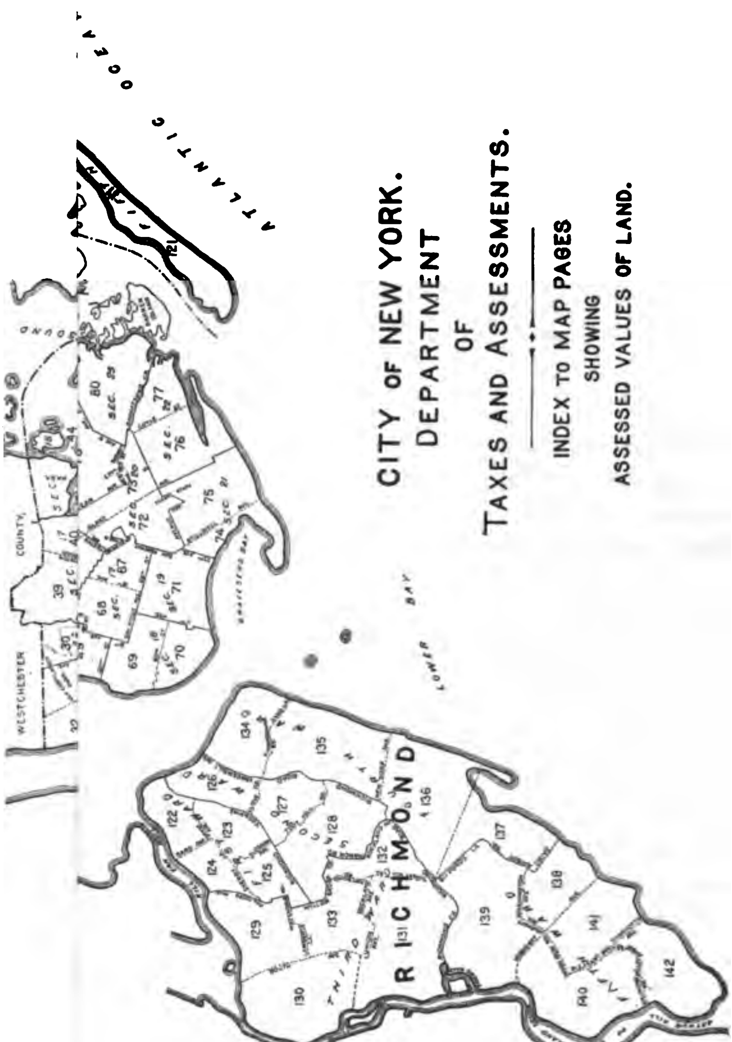
The block map of taxes and assessments is designated the permanent tax map. The permanent tax map has been completed for all of the territory in Greater New York, for which a definite street system has been established, including all of the boroughs of Manhattan and Brooklyn and the portion of the Borough of The Bronx west of the Bronx River. The tax map for the remainder of the city is termed the tentative map.

Greater New York, Chapter 378, Laws of 1897.

The largest addition of land to the City of New York was made on January 1, 1898, pursuant to the provisions of Chapter 378 of the Laws of 1897, when 260 square miles were added to the area of the city. Let me review briefly the growth of the city, giving the areas in square miles for each borough, in multiple of 20, which will be an approximation that can easily be remembered:

From 1652 to 1874, the Island of Manhattan, 20 square miles, constituted the City of New York. In 1874 the addition of the Twenty-third and Twenty-fourth Wards, containing 20 square miles, making 40 square miles, doubled the area of the city. In 1895 the Twenty-fourth Ward was enlarged 20 square miles by the addition of what is now the East Bronx, making in all 60 square miles, or

PLATE 107.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
VOGEL ON
HISTORY OF TAXATION OF REAL ESTATE
AND TAX MAPS OF THE CITY OF NEW YORK.



three times the area of the original city, and, in 1898, the cities of Brooklyn and Long Island, the towns of Newtown, Flushing, Jamaica and a portion of Hempstead, and Staten Island, consisting of the towns of Castleton, Middletown, Northfield, Southfield and Westfield, were added to the city, this last addition containing 260 square miles, makes a total of 320 square miles, 16 times the original area. A table of the approximates and exact area of each borough is as follows:

	Approximate Area.	Exact Area.
Manhattan	20 sq. miles.	21.93 sq. miles.
The Bronx.......	40 " "	40.65 " "
Richmond	60 " "	57.19 " "
Brooklyn	80 " "	77.62 " "
Queens	120 " "	117.36 " "
Total	320 sq. miles.	314.75 sq. miles.

The taxes in the municipalities annexed to the city in 1898 had been levied and collected in advance, whereas in the city as it existed prior to 1898 the taxes for the year were collected in October and November of the current year, so that in 1898 taxes were collected for only Manhattan and the Bronx, thus affording an opportunity for preparing tentative tax maps for the newly annexed territory.

The law provided that the deputy tax commissioners must begin their field work of examining the property for the succeeding year's valuations in September, and that they must assess in in accordance with maps and map numbers. It was therefore necessary for the surveyor of the Tax Department to have some of the maps in each of the districts into which the city has been subdivided ready for the deputy tax commissioners before the 1st of September, 1898, so that opportunity could be afforded to prepare the necessary field books in which the map numbers, the size of plot, and, if improved, the number and size of the buildings on the plot, were entered, which facts as far as the map designations and dimensions of the plot were concerned, were taken from the tax maps. All the maps had necessarily to be completed before the second Monday in January, 1899, on which date the law provided that the maps and records should be open for public inspection.

There were no tax maps for 171 square miles of the 260 square miles annexed in 1898. In the Borough of Brooklyn, the town of

New Lots, added to the City of Brooklyn in 1886 and designated the Twenty-sixth Ward, had no tax maps for the portion south of Vandalia Street. The entire town of Flatlands, added to the City of Brooklyn in 1896 and designated as the Thirty-second Ward, had no tax maps. Tentative tax maps were prepared for these two portions of the Borough of Brooklyn for the tax of 1899.

In the Borough of Queens tentative tax maps were prepared for the towns of Newtown, Jamaica and the portion of Hempstead in the city limits for the tax of 1899, and for Long Island City and the town of Flushing which had tax maps, although not all that could be desired, new maps were prepared for the tax of 1900.

In the Borough of Richmond, at the time of annexation, there were tax maps for the town of Castleton and portions of the towns of Middletown, Northfield and Southfield. These maps were revised and new maps made for the remainder of the borough.

It was necessary to study the methods of taxation in the many municipalities annexed to the city in 1898, in order that the transition from the former methods to the new methods could be made as simple as possible.

With the exception of the City of Brooklyn, nearly all of the municipalities had taxed the owners, not the land, the owners were divided into two classes, resident and non-resident, and in each class the names of the owners were arranged alphabetically in the tax records. It is self-evident that no extended survey could be made of the vast area to be mapped in a little over six months; a portion of the time being taken up in organizing a corps of men and familiarizing the men with the work. The names of the owners on the former tax records were searched against as grantees in all the offices of record of land conveyances, in order to obtain descriptions of property from the deeds, and all filed property maps referred to in the deeds were copied; this information was sent to the office in Manhattan, where the descriptions and maps were assorted and indexed under the several wards or towns, and one man placed in charge of the mapping of each ward or town. Auction sale maps, the maps of the United States Coast and Geodetic Survey and maps showing the water grants granted to private individuals—which latter maps contain a survey of the upland adjacent to the water grant—were all great aids in the preparation

PLATE 108.
THE MUNICIPAL ENGINEERS
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VOGEL ON
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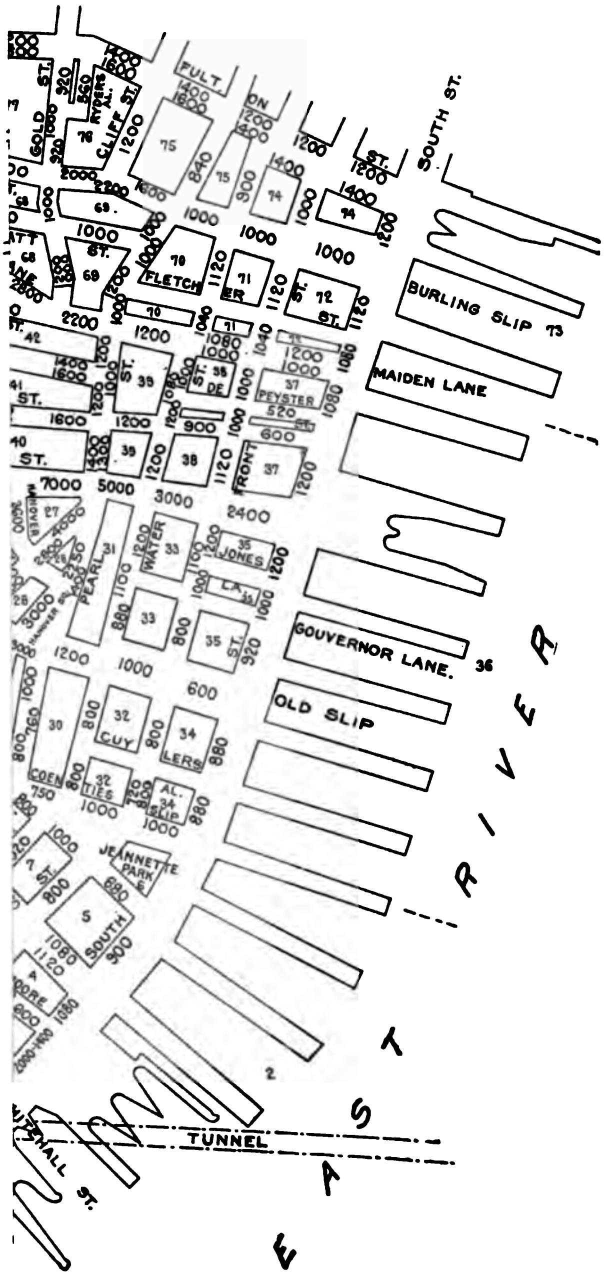
AND TAX MAPS OF THE CITY OF NEW YORK.



ures in the Streets Represent
d Feet in Depth.

of tentative tax maps. The searches in Staten Island showed that formerly each owner had three kinds of property, a residence plot, some acres of salt meadow and a woodland lot, which were widely separated; the salt meadow and woodland, with few exceptions, have no physical boundaries on the ground, are very poorly described, linear dimensions and bearings rarely being used; sometimes an approximate area is given; in most cases only the names of adjoining owners are given, and since many of the descriptions date back over one hundred years and families have become extinct, genealogical studies were frequently necessary to obtain relative locations. A similar state of affairs existed in the meadow lands of the outlying towns which had been added to the City of Brooklyn. The New Utrecht meadows, for instance, were not in New Utrecht, but belonged to the people who lived in New Utrecht.

The indefinite descriptions of the meadow lands in the Boroughs of Brooklyn and Queens, and of the meadow and woodland in the Borough of Richmond, will undoubtedly necessitate litigation in the future, unless the owners enter into agreements fixing definite boundary descriptions.

Public Service Corporations.

The special franchise law, Chapter 712 of the Laws of 1899—at the time of its passage known as the Ford franchise bill, Senator Ford being its sponsor—first made the intangible property of public utility corporations assessable as real estate, its underlying principle being that the privilege of using the public highway for the maintenance of wires, tracks, pipes, etc., is a form of real estate. The application of this law has been a fruitful source of litigation and has had several amendments. It is not the object of the author to go into its merits or defects, but since it is a real estate tax it is necessary to designate it with a map number. The tangible property of public service corporations had been assessed for many years prior to the passage of the law in question.

Where the land of the corporations is not in the public highways, the assessments are always made by the local authorities. Where the corporation occupies the public highways, the state board of assessors fixes the assessed valuations and forwards such valuations to the local authorities for the collection of the tax; where the corporation crosses a highway, and the crossing is less than 250 ft. in

length, such crossing was at one time assessed by the State and at another by the local authorities. Frequently, the corporation is the grantee of a turnpike company or owns the fee of its narrow right of way which is afterward widened and becomes a public thoroughfare. Where a corporation owns the fee of the land there is no franchise tax.

The following method of numbering the real estate of corporations is adopted: Each corporation receives a number known as its corporation number, which number is the same for all the boroughs in which the corporation has rights; if the corporation owns private property, each parcel of private property receives in addition to the corporation number a parcel number, beginning with parcel number 1 and continuing numerically upwards; when a public thoroughfare is crossed by a corporation, the adjoining parcel number is used with a designating letter. In addition to the corporation numbers the private property of a corporation always has its block and lot number, which latter numbers are a great assistance in finding the property of the corporation in the record books, which will show by whom and how the property is assessed.

Revocable Privileges.

The use of the public thoroughfares by a private individual or corporation for private purposes is termed a revocable privilege. This privilege is granted by the Board of Estimate and Apportionment, and usually consists of a tunnel under or bridge over a street connecting buildings owned by the same individual or corporation on opposite sides of a street, for the installation of pipes for steam, salt water refrigerating fluid, or electric wires, and for the passage of patrons or customers in the case of bridges. The locations of revocable privileges are shown on the tax maps and numbered for taxation purposes.

A Separate Statement of the Value of Land in Assessments of Real Estate and for the Publication of the Annual Record of the Assessed Valuation of Real Estate in the City of New York, Chapter 454, Laws of 1903.

Prior to the enactment of this law the deputy tax commissioners gave in the annual record of assessed valuations in one item the sum for which, in their judgment, each lot or parcel

or property with its improvements under ordinary circumstances would sell. The new law provided for two items recorded in adjoining columns, in the annual record books: First, the sum for which, in their judgment, each separately assessed parcel of real estate under ordinary circumstances would sell if it were wholly unimproved; and second, the sum for which, under ordinary circumstances, the same parcel of real estate would sell with the improvements, if any thereon.

The law for separate valuations also provided that the annual record of the assessed valuation of real estate of each section, district or ward should be printed separately as a supplement to the city record, and that an outline map should accompany each section, district or ward. Where permanent maps are in use, a map showing all streets and block numbers instead of an outline map is published.

Land Value Maps.

The Department of Taxes and Assessments annually publishes land value maps. There are in all 142 maps covering the entire City of New York. The maps are drawn with the streets clear of printed matter to allow for recording the value per front foot of normal lots 100 ft. deep, which are not subject to corner influences. In the case of land in large tracts in suburban sections the value in dollars per acre is marked at a point near the centre of the tract.

Along the waterfront the method of marking is as follows: The bulkhead line is valued per lineal foot, and the figures are placed as nearly as practicable on the line, showing the value per lineal foot of the bulkhead line. Under the definition of real property in the tax law there is included as land "all wharves and piers, including the value of the right to collect wharfage, cranage or dockage thereon." This right is known in law as an incorporeal hereditament. In computing the value of waterfront property three elements are taken into account: the value of upland, which is shown on the maps by figures in the streets, just as in the case of other land; the incorporeal hereditament of bulkhead line, by figures showing the value per lineal foot, and the land under water, which is shown on the maps by a valuation per square foot of superficial area.

The purpose of the maps is to aid in the assessment by presenting to the view of the assessor all of his territory, with comparable

figures on every street; second, to aid the commissioners in passing upon applications for reduction of assessed values, and third, to enable the public to judge of the fairness of the assessment and to aid the Department by suggestions and criticisms.

Value of Buildings.

The value of buildings is computed by multiplying the square feet of floor space by an appropriate factor. The factor is obtained from the cost of construction. The various kinds of buildings are classified and graded.

Buildings depreciate in value, become obsolete, and at times a valuable building is not adapted to its environment. "It is almost universally true that an improved parcel of real estate is never worth more than its capitalized rental value until the land alone exceeds in value this capitalized sum."

Map Alterations.

The tax maps are altered for the following reasons:

1.—Subdivision of farms and large parcels of land.

2.—Consolidation of small plots for the erection of large buildings.

3.—Transfer of narrow strips of land for party walls or for the purpose of clearing title on account of encroachments and errors in conveyancing.

4.—Lands acquired for public purposes, such as streets, parks, playgrounds, aqueducts, reservoirs, subways, bridges and waterfront improvements.

5.—Changes in existing street plans and the adoption of new street plans.

The alterations on the tax maps for the year ending September 30, 1912, affected 30 633 lots or parcels of land.

The total number of parcels of real estate assessed for the year 1912 is 523 330.

The number of volumes of tax maps in the different departments

now in actual use for purposes of levying taxes, water rents, assessments and arrears, is as follows:

Department of Taxes and Assessments..........	264
Duplicates used by Deputy Tax Commissioners...	264
Comptroller's Office, Bureau of Arrears..........	186
Department of Water Supply, Water Registrar...	186
Total	900

The author has endeavored to keep this paper as free from statistics as possible, and to present some facts not readily accessible.

DISCUSSION.

WILLIAM F. JOHNES, M. M. E. N. Y.—Mr. Vogel says that, in determining the assessed value of property, the value of the lots is taken at the selling price of land in the vicinity, and then the value of the improvement is fixed on the basis of multiplying the number of square feet by a certain constant. What method is used in arriving at this constant?

HENRY W. VOGEL, M. M. E. N. Y.—The constant is based on the cost of construction. Buildings are divided into different classes and grades; there are different grades of dwelling houses, different grades of apartment houses, different grades of lofts, different grades of office buildings. You will find in the report of the Commissioners of Taxes and Assessments quite a detailed account of how the constant is determined. In the calculation, the floor area is taken, rather than the cubic contents of the building. If a building is 25 by 60 ft., you can easily get the area of one floor, and if it is five stories high, you multiply that by five, then again by the constant. Some frame buildings are assessed as low as one dollar per square foot, and some dwellings as high as $10 per square foot of floor area.

Where buildings depreciate in value with age or change in environment, the rental value capitalized is the value of such a plot until the land alone has more value than such capitalized rental value.

SIDNEY W. HOAG, JR., M. M. E. N. Y.—Mr. Vogel, what was the fundamental principle that controlled the original ward subdivision? Was it purely arbitrary?

MR. VOGEL.—It was defined by an ordinance of the Council in 1683. The wards are also well described in that ordinance and are also described again in the Montgomery Charter.

The description was given by property lines, and one of the lines was the rear of the dwelling houses that front on the easterly side of Broadway.

AMOS L. SCHAEFFER, M. M. E. N. Y.—Does the statute describe how the land shall be valued for taxation? Is the value determined by the selling price under ordinary conditions?

MR. VOGEL.—It was at one time fixed that the assessed valuation was to be two-thirds part of the rental value for one year, and, subsequently, it is mentioned in different charters that it is to be the value for which such property would, under ordinary circumstances, sell.

The Department keeps records of every conveyance of property in which a substantial price is given in the deed of sale. However,

many of the deeds give nominal values; some give fabulous values, for certain reasons. The Department keeps in regular order all leases and mortgages. A mortgage is possibly a very good criterion of the value of the property, especially if the mortgage is given by a bank or some financial institution, because the banks rarely give a mortgage for more than two-thirds of the value of the property. All these records are kept and tabulated, and are accessible to each one of the deputies. Field books, kept by the deputies, are arranged to cover from seven to ten years' taxes. In this field book the deputy notes opposite each lot anything that transpires that would help to fix a value. It is surprising how some of these deputies keep in touch with their districts. They know what the asking price is for each house on the market, although that is rarely the true value.

Some experts in Queens have stated that when you develop farm property and cut it up into lots, 40% of the price of sale is the cost of putting it on the market, so that if a lot sells for $1 000, probably it nets $600. Some of you have noticed the advertising of the Schmidt property in The Bronx. The auctioneer spent an enormous amount of money, and even went so far as to publish music. The results show that it pays.

THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.

Paper No. 77.
PRESENTED DECEMBER 23, 1912.

THE PARKS OF NEW YORK CONSIDERED FROM A PROFESSIONAL STANDPOINT.

BY CHARLES DOWNING LAY, M. M. E. N. Y., F. A. S. L. A.*

WITH DISCUSSION BY
NOAH CUMMINGS, SIDNEY W. HOAG, JR., BERTHOLD SCHEIMAN, ALFRED D. FLINN AND CHARLES DOWNING LAY.

The modern method is to begin the study of any subject with a diagram, and there is merit in the idea because a diagrammatic classification is helpful as a means of correcting wrong impressions as to relationships and as a means of giving one a mental background which becomes of value in a critical study.

The diagram on the opposite page shows roughly the relationships of different kinds of parks to each other and to the park system as a whole. Just as the child is father to the man so should the playground be the father of the park systems.

The next in importance is the city square, which is (or should be) a sort of playground for adults. Then comes the neighborhood park, which is a playground and park for all ages, and forms the connecting link with the rural parks. These are followed by the wild or extra-mural parks.

All, as may be seen, are connected or interrupted, as the case may be, by specialized parks, scenic parks, communicating parks and historic parks. These classifications cannot be rigid. Many

* Landscape Architect, Department of Parks.

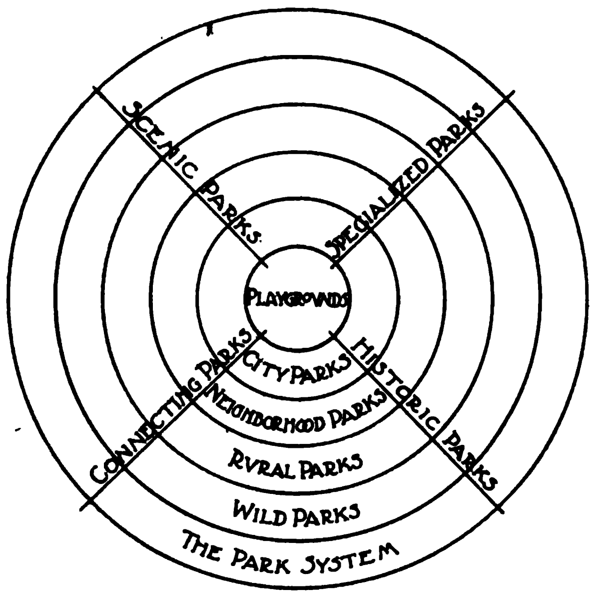

SCENIC PARKS
SPECIALIZED PARKS
PLAYGROUNDS
CITY PARKS
CONNECTING PARKS
HISTORIC PARKS
NEIGHBORHOOD PARKS
RURAL PARKS
WILD PARKS
THE PARK SYSTEM

PLATE 109.

parks may serve two purposes, as playground and school or museum and specialized, etc., but most parks will be found to have predominating characteristics surely entitling them to classification under one or another of these headings.

New York's parks are as poor an illustration of a park system as a person without arms or legs would be of the genus homo. It has examples of varying merit of all classes of parks, but they are mostly unrelated and unconnected. They could be made into a worthy system, but one that would never equal a system developed from the beginning with the object of completeness of function and relationship. This is a great pity because it is only as a part of a system that any park can fully satisfy the uses for which it was designed.

The weaknesses in New York's park system are caused partly by geographic obstacles, but mostly by lack of foresight and by the method of taking park lands. Commonly, park lands are taken because someone who has land to sell works up a popular demand for a park in that neighborhood. The demand is heeded by the authorities, and on investigation it is usually found that the most available site is that owned by the man who has worked up the demand. Seldom, indeed, is land taken because its location and character fit it to serve perfectly for park uses, and so far as I know there is no official map showing lands to be taken in future for park purposes nor any scheme carefully worked out on paper, nor is there anybody charged with the duty of planning for the park needs of the future. Everything is haphazard, accidental, and the results are, of course, only half what they should be under a farseeing scheme for future development.

New York's parks can only be brought into a system by great cost of labor and money. An attempt is being made, however, with Riverside Drive which some day will go to the Harlem River, and could connect over the Hudson Memorial Bridge with the parks of the Bronx.

The benefits that would come in New York from a perfect park system are nearly impossible to list, they are so numerous, but the ones which concern a professional study of the park are, among others: (1) better distribution of park areas; (2) a higher specialization of individual parks; (3) a greater use of all parks; be-

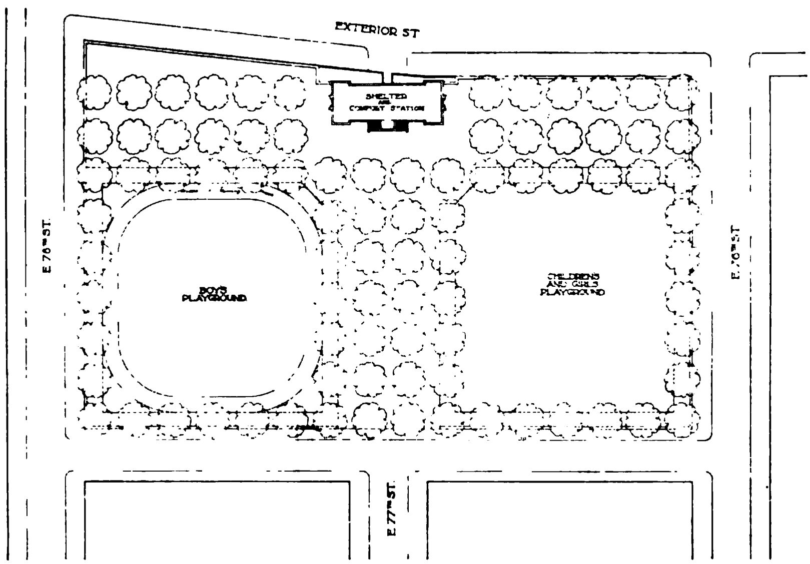


PLATE 110.—JOHN JAY PARK.

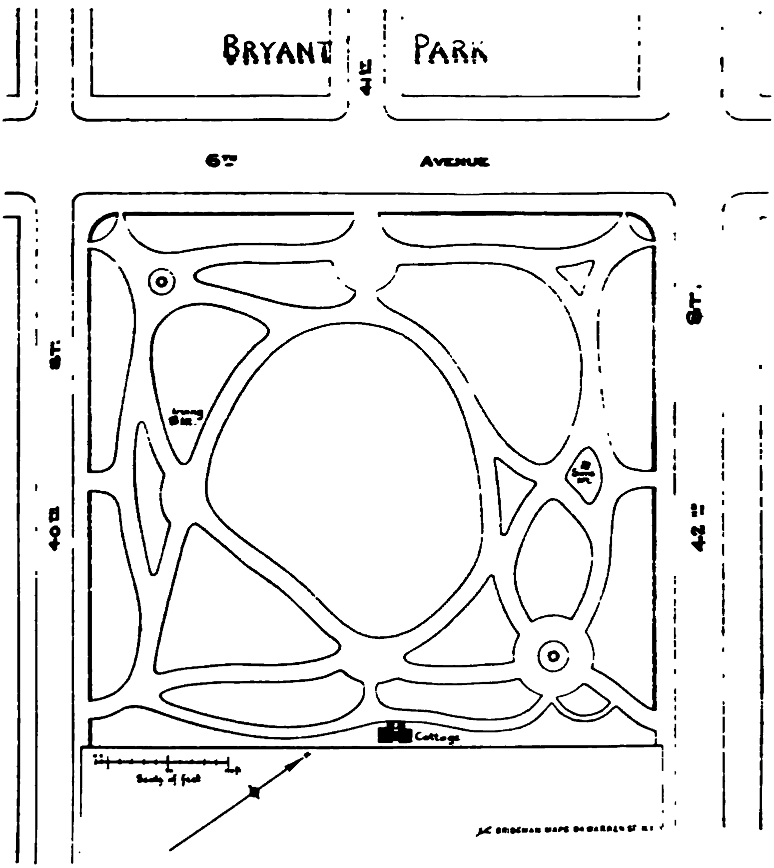


PLATE 111.—BRYANT PARK, AS IT IS.

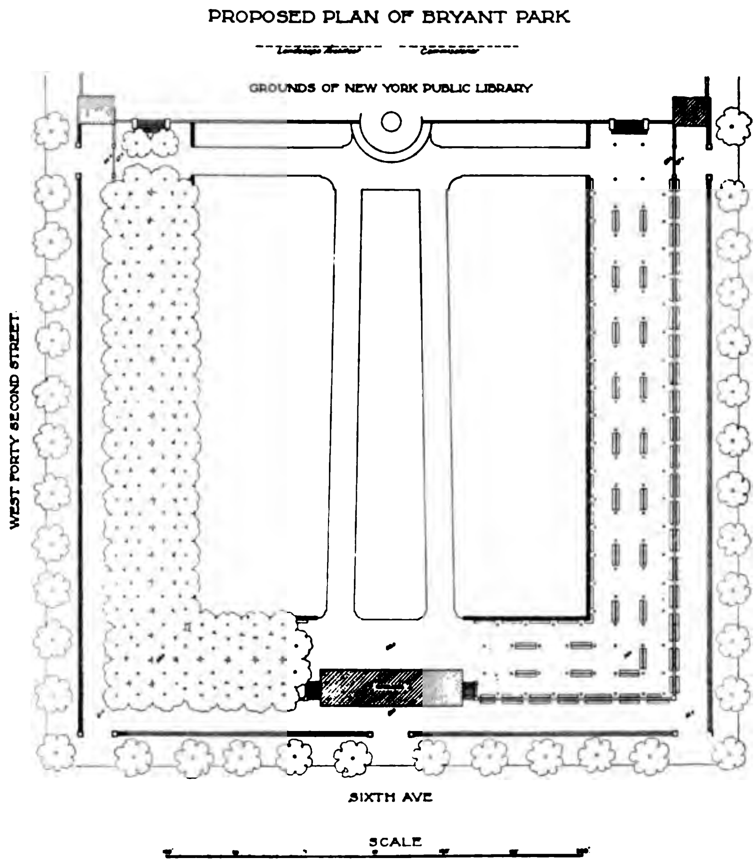


PLATE 112.—PROPOSED DEVELOPMENT OF BRYANT PARK, PROVIDING A MALL AND LARGE LAWNS.

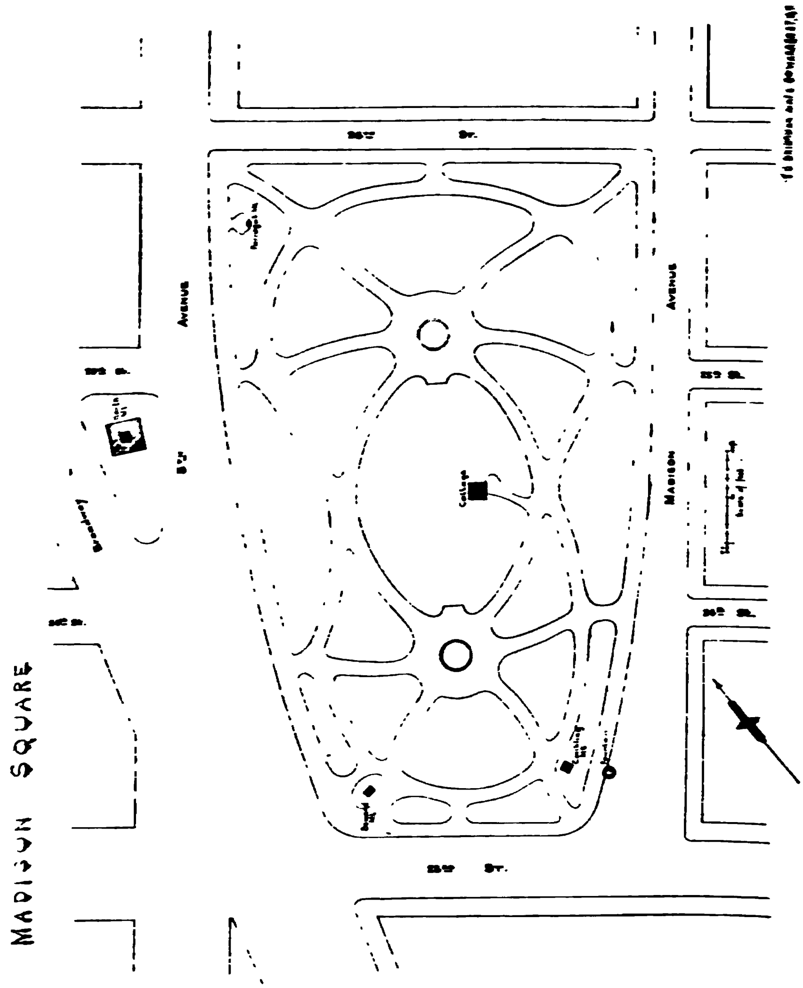


PLATE 118. MADISON SQUARE, AS IT IS.

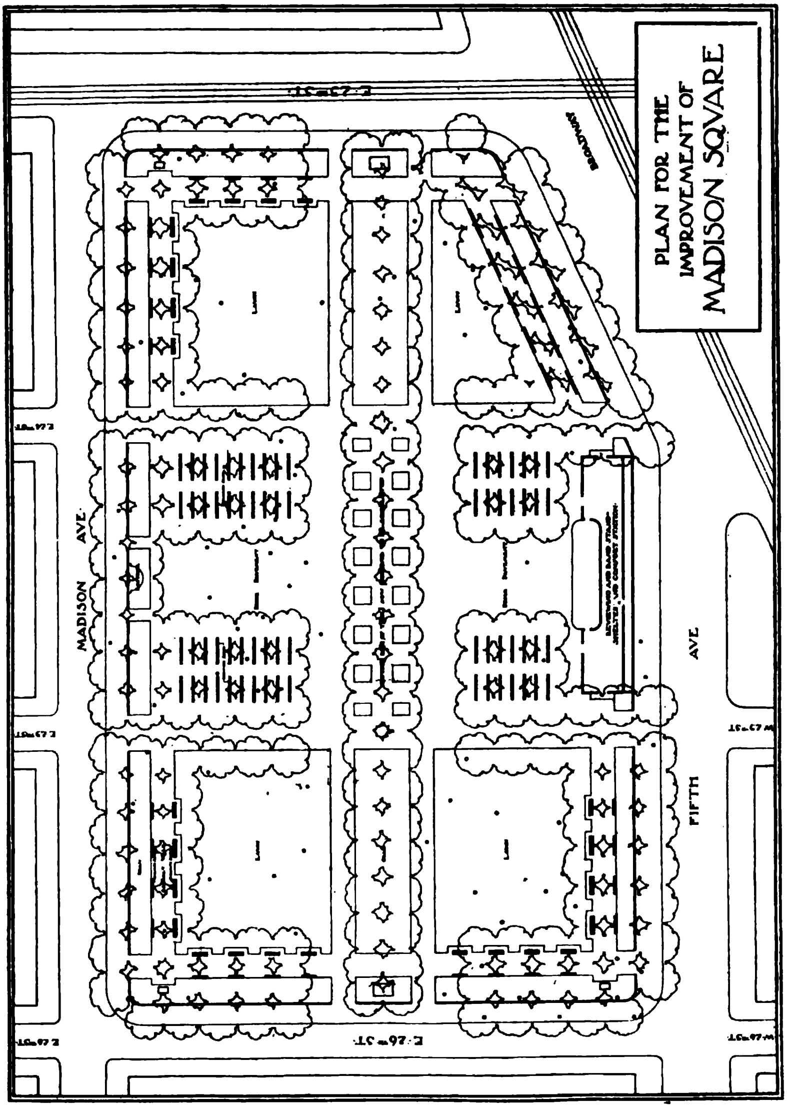


PLATE 114.—MADISON SQUARE AS IT MIGHT BE. SHOWING A BETTER ARRANGEMENT OF LAWN AND WALK AREAS, PAVED SPACE FOR CONCERTS AND MEETINGS, CONCERT PLATFORM, ROSTRUM, COMFORT STATION, AND REVIEWING STAND.

cause each one being a link in the chain it would have a function not only as an individual link but also as part of the chain. The power of a well-conceived park system to increase property values is too large a question for consideration here.

The Parks in Detail.

Greater New York has no good examples of a small playground. The reason for this is, I suppose, that the playground idea has, until recently, been frowned upon by the authorities. There are small areas which are called parks but which serve no useful purpose and might better be rebuilt as true playgrounds. Such is Mulberry Bend Park, which was made a park because that was the easiest (or, perhaps, the only) way to get rid of an area of tremendous congestion of population. As a park it has never done full duty, and now that one of the lawns has been taken as a playground, it is no longer a park, neither is it a good playground.

W. H. Seward Park, Corlears Hook Park, Hudson Park, McLaughlin Park, McCarren Park, are all rather poor parks, now half playgrounds, which should be rebuilt.

The perfect playground must provide separate areas for boys and girls, not surrounded by park walks, where prurient minded people congregate to watch, but secluded and protected from such observation. The playground should not be a thoroughfare, but should have a few and easily controlled entrances. The playgrounds should be shaded on the borders and there should be a shaded mall gravelled, if possible, for the mothers, and babies too small to play alone. It should have a large house with rooms for play on rainy days, ample toilet and bath facilities, which, however, should not be open to the general public. The building and the mall should be capable of use for concerts and educational meetings.

John Jay Park (Plate 110) and the 151st Street playground are attemps to approximate these conditions. In the latter it was not thought wise to divide so small a space for separate use for boys and girls. Instead the age limit will have to be kept low. Any attempt at park-like treatment is, I think, wisely abandoned in such grounds as these.

A mile apart is generally considered the maximum distance for playgrounds.

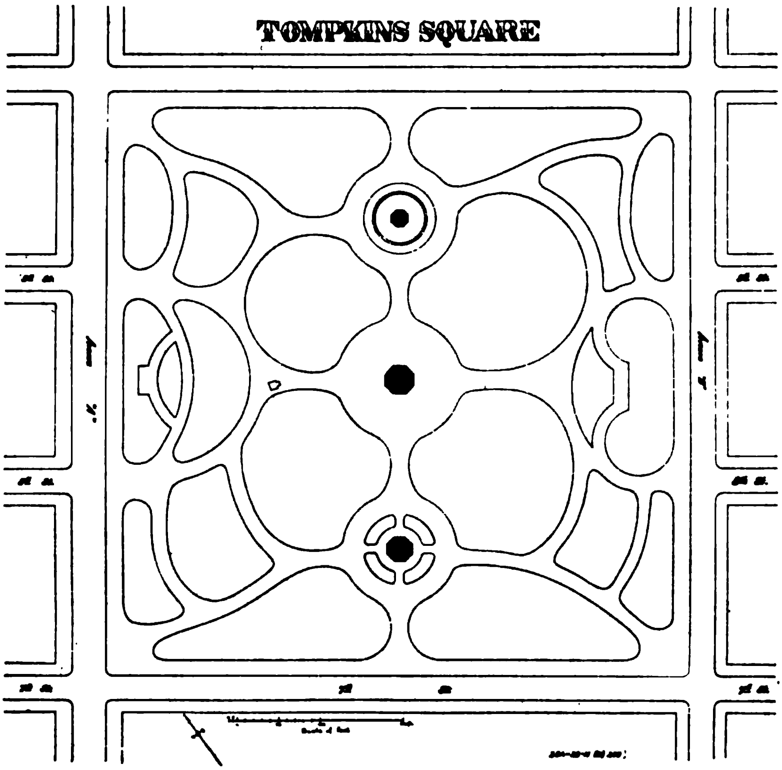


PLATE 115.—TOMPKINS SQUARE. A POOR DESIGN. THE RELATION OF WALK AND LAWN IS NOT GOOD AND THE PARK IS WITHOUT BEAUTY.

City Parks.

The city park, as I have said before, is only a playground for adults and it should allow considerable freedom of movement. Shaded walks, paved areas for mass meetings, statuary, fountains, ornamental shelters, and architectural details should predominate. Grass and ornamental planting should be used with restraint and only for decoration. Examples of such parks are City Hall Park, Union Square, Madison Square and Bryant Park. The present plans for these are shown and studies for the rebuilding of two of them.

Neighborhood Parks.

The neighborhood park is a type at present unknown in New York, but it has reached a high development in Chicago. Its function is to serve as a country club for city people. Its minimum size is about ten acres and they should not be more than two to two and one half miles apart. They may conveniently replace one playground in the ideal scheme. They should have most of the facilities of the country club except the bar and golf links. A large house for lectures, theatricals, dances, club meetings and receptions is essential. There should also be a large swimming pool with dressing booth house, indoor and outdoor gymnasiums for men and women, boys' and girls' playgrounds and a special babies' playground with swings, sand piles and wading pool. The concert grove, which in the day time may serve as a meeting place or forum, is, of course, indispensable.

Tompkins Square in New York (Plate 115) is the right size, and is in a congested region where such a development would do much good. At present it is nearly useless. The walk area is too small and the lawns, which cannot be opened to the public, too big. In its present state it represents an annual loss to the city, being as it is, an unimproved and unproductive piece of property.

Rural Parks.

The rural park has always been our ideal of what a park should be and it is a noble ideal. New York has the first and finest examples of such parks in Central Park, Prospect Park, Forest Park and several others. The object of such parks is to simulate the

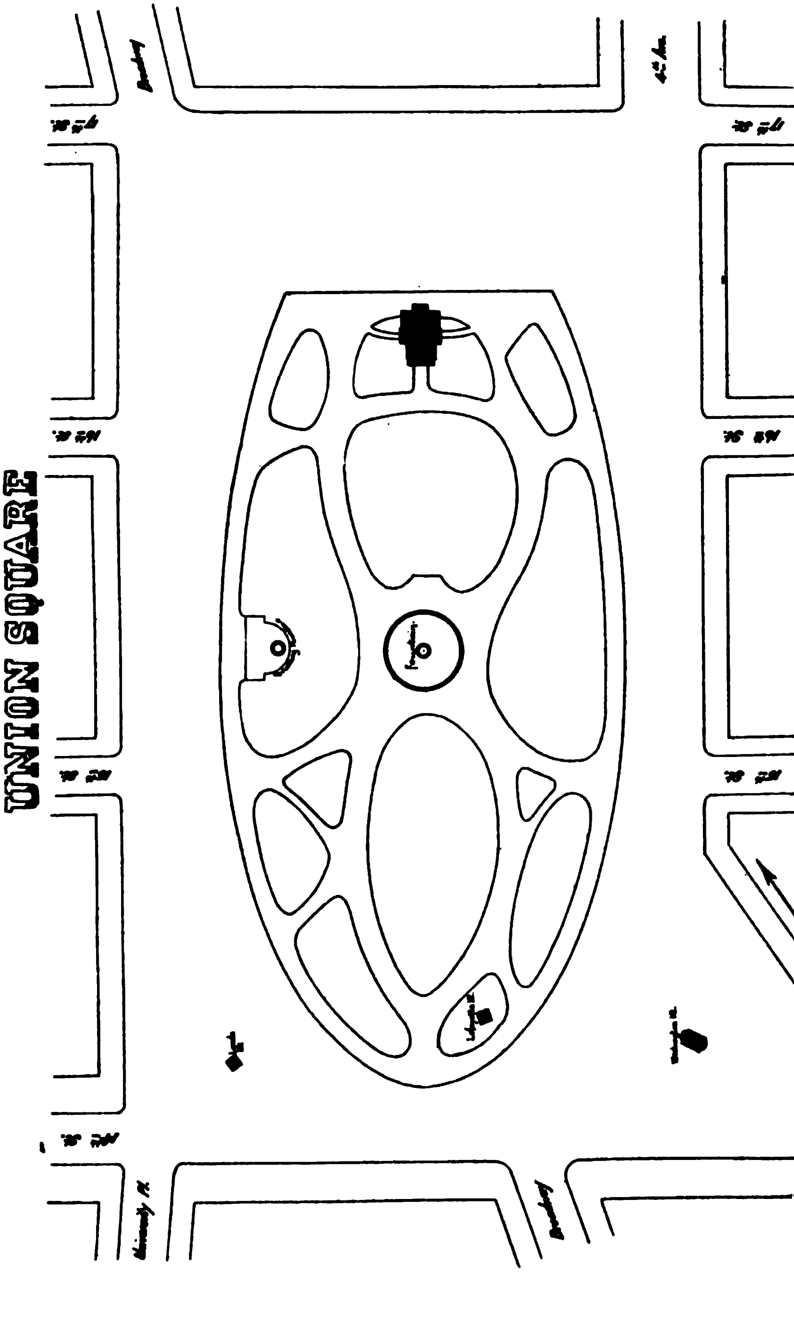


PLATE 116.—SHOWING THE SUBURBAN TYPE OF PARK DESIGN, ADMIRED IN 1871, BUT NOW CONSIDERED UNSUITABLE. NOTE THE ENORMOUS AREAS GIVEN TO ROADWAY WHICH MIGHT BETTER BE RECLAIMED FOR PARK USES.

beauty of the country and to bring to minds and nerves, tired out by the rush of city life, the peace and quiet which comes from the contemplation of rural scenery. The pleasure of the senses is everything. Exercise, physical recreation, amusement, may be provided but must be kept subordinate if the park is to fulfill its purpose. Large size is the first essential of such a park because such effects can only be produced by great extent of lawn, shrubbery and forest. The roads and walks and all features necessary to make its use possible must be kept out of sight and mind. Water in brooks, rivers or lakes is much to be desired, and hills, hollows, rocky eminences and ravines will add to the effect.

Wild Parks.

New York has at present no wild parks but it has in the lands controlled by the Board of Water Supply, tremendous areas of land which will soon be wild and which could easily be used for long trips, either walking or motoring and for camping. Other cities have large park areas outside their boundaries which are used in just such ways. New York should have them.

Scenic Parks.

The scenic park may be any area large or small reserved for the purpose of saving from destruction some natural beauty. Thus Morningside Park might be classed as a scenic park. Fort Washington Park certainly belongs in this class though it is also historic, but it is hard to say whether Riverside Drive should be classed here or in the next group since it is also a connecting park.

Connecting Parks.

Like Pelham Parkway, connecting parks serve the useful purpose of connecting one park with another and thus giving continuity to the system.

Historic Parks.

Historic parks have as their object the preservation of some feature of historic interest. Roger Morris Park, which contains the Jumel Mansion, Fort Greene Park, King Park and others are historic parks.

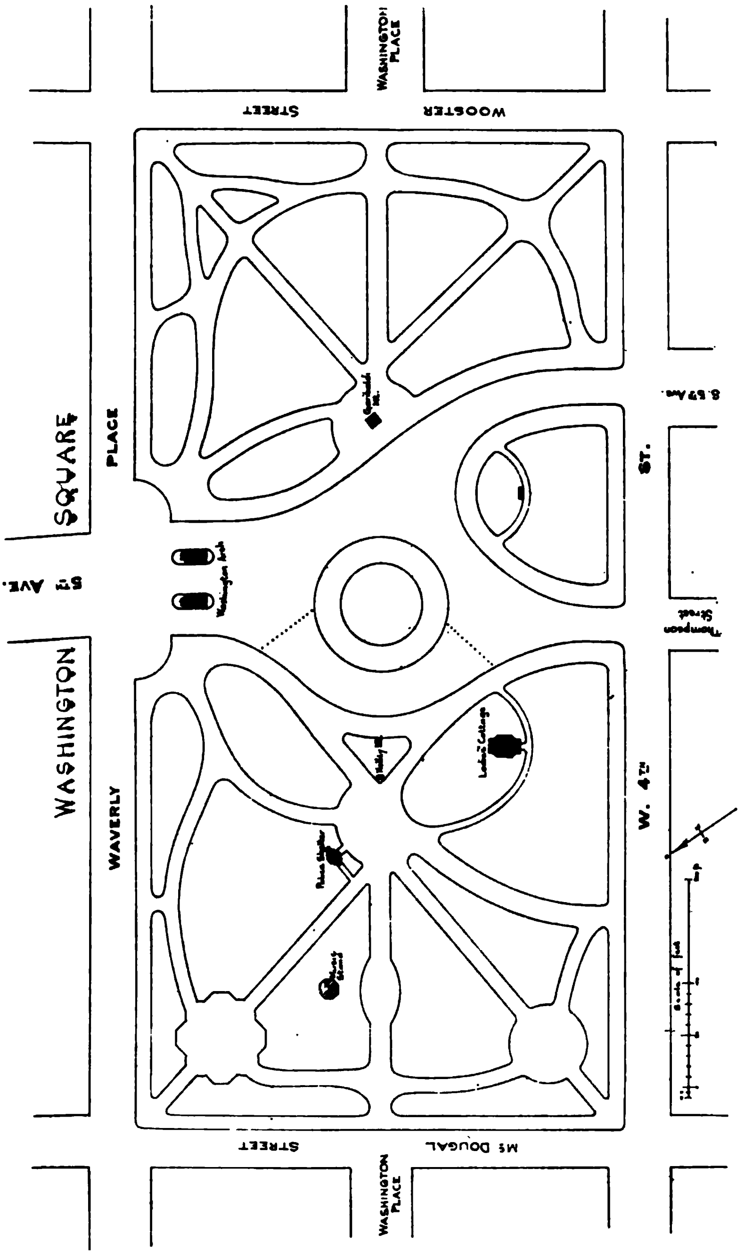


PLATE 117.—A PARK WHICH HAS SURVIVED ITS USEFULNESS. THE ROADWAYS ARE NO LONGER NEEDED FOR PLEASURE DRIVING AND SHOULD BE ABOLISHED GIVING MORE ROOM FOR PLAY SPACE, LAWNS, ETC.

Specialized Parks.

Specialized parks are set aside to serve some special ends. Thus, Dreamland Park will be a bathing park. The Bronx River Parkway when completed may be a canoeing park as well as a connecting park. The Botanic Garden and the Zoological Gardens are specialized parks.

Parks in the Different Boroughs.

Studying the parks of the boroughs separately, it will be seen that the Bronx is fairly well provided with large parks and has some connecting parks. Nothing could be finer than Pelham Bay Park and Van Cortlandt Park. Both are large, interesting and well adapted for park development. The Bronx, however, has no Hudson River Park. One should be acquired. The Bronx is deficient, however, in smaller areas to be developed later as playground, city and neighborhood parks.

It was right to get the large parks first. Large areas can only be acquired when the city is new, and small ones are not so much needed because there is so much chance for play in vacant lots. Now, however, that the Bronx is being built up so rapidly, it is important to get the small parks.

In Queens there are few parks, but a wonderful opportunity to create a thoroughly good park system. A beginning has been made in the recently acquired Rockaway Park.

Brooklyn has in the Shore Drive a scenic park rivalling Riverside Drive, and, like Riverside Drive, it is unconnected with other park areas. It should be carried past Fort Hamilton through Dyker Beach and to Coney Island, and at the other end it should in some way be brought nearly to the Brooklyn Bridge. Brooklyn needs several more rural parks like Prospect Park, and innumerable playgrounds, city and neighborhood parks. Fort Green Park and Sunset Park are both useful and admirable parks which might some day have a few features of the neighborhood parks. The old part of Brooklyn is badly provided with parks, and the newer parts may soon be in the same condition.

Richmond is virgin territory where anything can be done. The opportunities are marvelous.

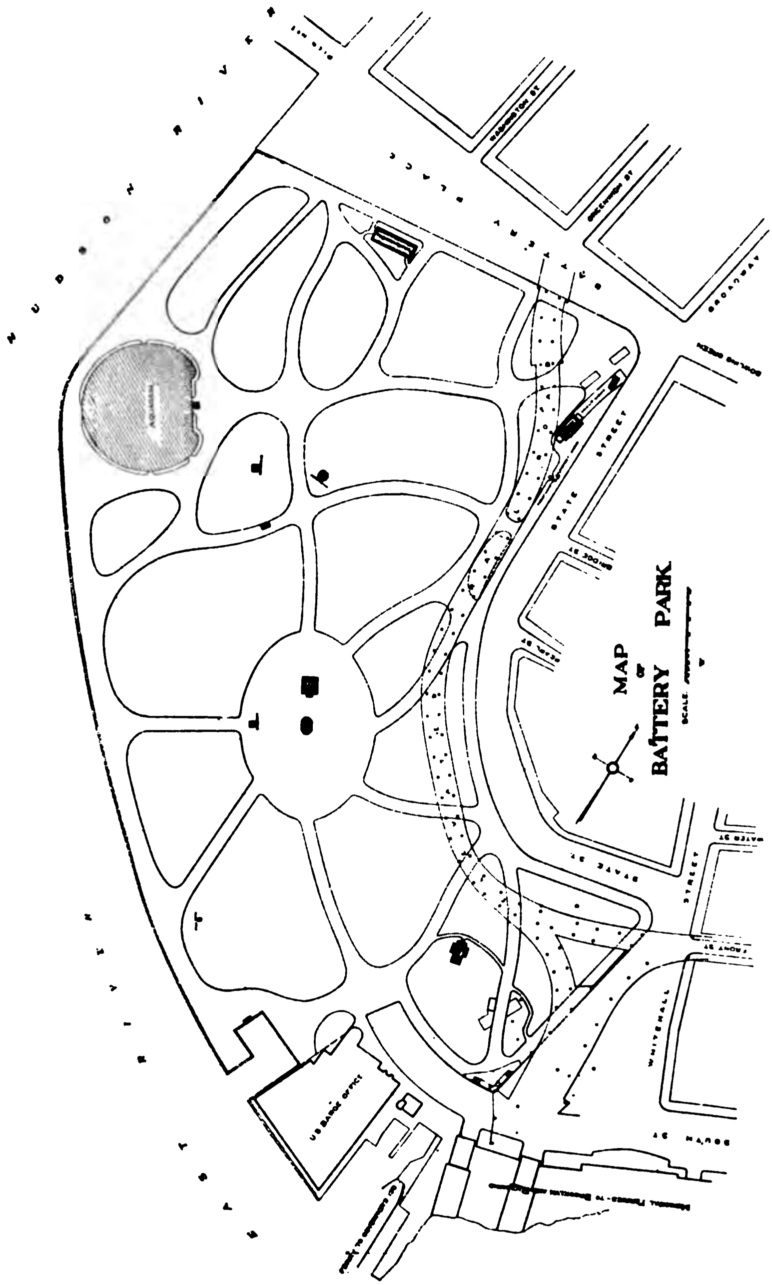


PLATE 118.—A PARK ILL ADAPTED TO PRESENT NEEDS, BECAUSE IT IS NOT DESIGNED TO TAKE CARE OF THE CROWDS WHICH SOMETIMES GATHER THERE.

Manhattan, as we have already seen, has no park system and cannot have one. The crying need is for playgrounds and neighborhood parks. It should also have facilities for public bathing either in many small pools in small parks or in several large pools on Riverside Drive supplied with filtered Hudson water. There should also be provision for boating and the city should maintain public boat houses.

General Remarks.

In a city where the changes are so rapid as in New York it often happens that the character of a region around a park changes so markedly that the park becomes comparatively useless. This has happened to Tompkins Square, as noted above, and to Stuyvesant, but in this case the region though changed keeps much of its old spirit because of the institutions around it.

Washington Square and Madison Square used to be the hearts of the most fashionable neighborhoods. One is now a region of sweat shops; the other is devoted to offices and retail trade. They are fast changing again to no one knows what. Both should be rebuilt to serve their new uses better.

Union Square is less changed in twenty years than the others, yet it is changing and that park now should be done over to fit the increasing use.

Bryant Park, because of the Library, must always be an oasis in the desert. Seclusion should be the object there, and the ideal of a city park must be abandoned in that case. All these parks, including the Battery, were done in the lowest stage of our artistic life, 1871, and are, therefore, changed with less regret.

Management of Parks.

Much could be accomplished in the park departments if they were all consolidated; if, instead of having four, there were but one, with one policy, one responsible highly-paid executive officer and a commission of five men to control the policy. The five commissioners should be removable only on charges. They should serve for long and overlapping terms. Thus, one might be appointed each year to serve for five years. In this way, instead of a complete change every four years or oftener, we should have a continuous

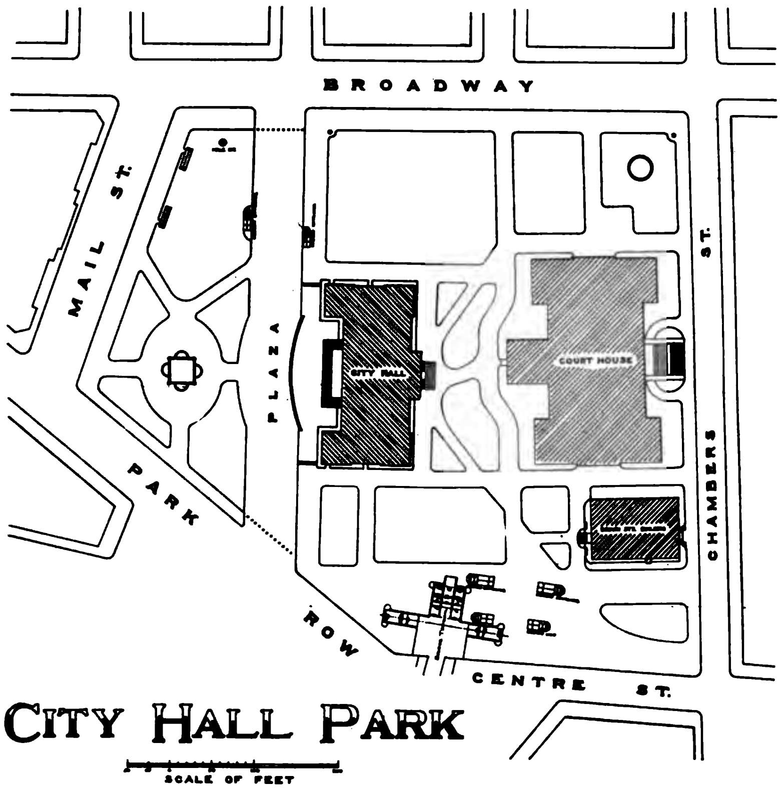


PLATE 119.—CITY HALL PARK, WHICH SHOULD BE REBUILT TO SERVE AS A BETTER SETTING FOR THE BUILDING AND TO GIVE A BETTER ARRANGEMENT OF WALK.

board of control, with a reasonably fixed policy, which in time could accomplish something. The park board should also be held responsible for a plan for future development, and no parks or parkways should be taken or built except upon their recommendation.

The following table shows park conditions in New York, by boroughs, as compared with Hartford, Conn.:

	Manhattan.	Brooklyn.	Bronx.	Queens.	Richmond.	Hartford, Conn.
Area (acres)	14 038	45 327	26 522	75 111	36 600	11 040
Population (1910)	2 331 542	1 634 351	430 980	284 041	85 969	98 915
Density (average population per acre)	166	36	16.2	3.7	2.3	8.96
Area of Parks (acres)	1 446.6	1 200.5	3 957.8	645.0*	67.5	1 371.39
Population per acre of Parks	1 611	1 360	108.4	440.6	1 273	72.15
Percentage of total area in Parks	10.3	2.6	14.9	0.86	.15	12.42

* Excluding Rockaway Park.

DISCUSSION.

NOAH CUMMINGS, M. M. E. N. Y.—I would like to ask what the Inspectors are doing on Riverside Drive, between Seventy-ninth and Ninety-sixth Streets, where they are filling in. Will there be docks all the way up?

SIDNEY W. HOAG, JR., M. M. E. N. Y.—Perhaps I can answer that question. At Seventy-ninth Street and at Ninety-sixth Street there is a stretch, 500 ft. north and south of each of these streets, that has, by legislative enactment, been reserved to the Dock Department. All the rest of that front is park property. That makes 1 000 ft. at Ninety-sixth Street and 1 000 ft. at Seventy-ninth Street which may be used for commercial purposes.

BERTHOLD SCHEIMAN, M. M. E. N. Y.—The engineers of the Board of Estimate have been very much interested in the matter of small parks. The question arose whether it would be better to assess abutting property for the cost of the park or whether to apportion it between the City and the abutting property owners.

CHARLES DOWNING LAY, M. M. E. N. Y.—I have thought a good deal about it. I think the small park may properly be charged on the abutting property, but the large park certainly should not.

ALFRED D. FLINN, M. M. E. N. Y.—There is another use of the parks which has not been particularly mentioned to-night, that is the possibility for the horseback rider to get a reasonable measure of pleasure out of New York parks or park system. I do not ride myself, but friends of mine say it becomes monotonous to ride over the bridle pathways in Central Park day after day. I would like to ask Mr. Lay if he, or any officer of the Park Board, has been thinking of the possibility of connecting Central Park with Riverside, or other park, for equestrians.

MR. LAY.—That is one of the great weaknesses in the so-called park system of New York, and we are now drawing plans with a view to continuing the bridle park from the present northerly loop, with some connection at One Hundred and Tenth Street, so that horseback riders can get to Riverside Drive.

THE MUNICIPAL ENGINEERS OF THE CITY OF NEW YORK.

ADDRESS OF S. WILLETT HOAG, JR., PRESIDENT OF THE MUNICIPAL ENGINEERS OF THE CITY OF NEW YORK.

PRESENTED AT THE ANNUAL MEETING OF THE SOCIETY ON JANUARY 22, 1913.

As this Society enters upon the second decade of its existence as an organization of municipal employees in the engineering branch of the public service, the prospect of continued future success seems to be assured after a retrospection of the first ten years of its existence. As an organization we have not only held together, but have increased in membership from 250 at the commencement of its career to 506 at the close of the year just past.

The work accomplished by an organization such as this may be measured not alone by the greater efficiency of its members engaged in the public service as a result of the papers presented from time to time and discussed by the membership at large, but as well by the influence which this greater efficiency undoubtedly exerts in matters connected with the different departments of the City government affecting policies and management.

The experiences of the past ten years afford a valuable guide for our progress in the future. Where so many different individual elements are gathered together, many engaged in the same line of engineering work, it would not be at all surprising if at times the weaker side of human nature should manifest itself by acrimonious debate, borne of jealous temperaments and a desire for self-exploitation, but the total absence of anything that would mar the harmony and successful deliberations of the Society, has been a marked feature at all of its gatherings. In other words, up to the present time the Society has "pulled well together", and the successful efforts of those who have contributed to its best endeavors has met

with a most generous support from the membership at large. Whether this is due to the fact that we are engineers and naturally dependent upon each other for interchange of ideas, or due to what should be a fact that we are all engaged in work destined to further the greatness of New York, matters little.

As public servants of the City of New York, we should continually keep in mind that idea of loyalty to the City which we represent, so commonly present and active in all other communities excepting the City of New York. In fact, in this City, it seems almost to take a negative form, and not only a passively negative form, but at times an extremely active one. Reference is here made to the dearth of exploitation, on the one hand, and the too plentiful supply of caustic criticism of public officials, and actual derogation of the City itself, on the other.

In a City growing as this one is, conditions continually change, and these in turn create further conditions which have to be met either by public or private measures, all of which present the great problems that mean millions of expenditures in their solution. For instance, we must have a more plentiful supply of water for all purposes. How shall we get it? We must provide means whereby the immense multitude of people that concentrate at the great business and commercial centers daily, may be taken there promptly in the morning and returned to their homes at night. How shall this be accomplished? The time has arrived when we have got to provide accommodations for the ever-increasing demands of ocean and coastwise commerce, and for the reception and transmission of railroad freight, all of which make up the life blood of the Metropolis. How shall we best accomplish this? And so on, with problems innumerable, many of which represent an investment of millions of dollars, sums which to-day in the aggregate, make the Panama Canal an incident by comparison. We are doing these things all the time, and it is safe that some of the biggest improvements and biggest enterprises, both public and private, go on here in this great City known to but comparatively few of its people.

How then can we expect exploitation or advertising? As a community we do not seem to care a farthing for that, or it may be that we are too fatigued after a day's work to give it much thought. The every day business or professional man ignores crosswalks during

[illegible]

[illegible]

The members of this Society [illegible] are in a position to lend the most valuable aid in handling and solving these big questions [illegible] of the City's progress in the best and most economical manner.

The most conspicuous work of the Society outside of its routine during the year [illegible] was the labor expended on the report which it was requested to prepare and transmit to the Comptroller, as Chairman of the Board of Estimate's Committee on the Standardization of Salaries and Grades. In July last the Chairman of that Committee requested the Society to present its views on this question affecting the engineering service, which request met with a prompt response by the appointment of a special committee by the President, the members of which represented every Department comprised within the membership of the Society. The hard work was done by a sub-committee of five which furnished the groundwork for the further deliberations of the special committee, the board of direction, and the Society at large, and while a report from the Board of Direction has twice been submitted to the Society, the matter still awaits final action.

This is the first instance in which the Society has been taken into the councils of the governing powers of the City, and in view of this recognition, which in fact is a compliment and expression of confidence, it is to be hoped that the matter will shortly receive wise and conservative final action by the Society.

Meetings.

The meetings of the Society have been more largely attended during the year than in the past. Ten meetings were held, at nine of which regular business was transacted. The highest attendance at the regular meetings was 407 in May; the lowest was 84 in December, and the average attendance was 197 as against 148 in 1911.

A special meeting was held in September for the purpose of considering the report of the Board of Direction on Standardization of Salaries & Grades of municipal engineers.

The May Meeting, Ladies' Night, was conspicuously successful when Col. William M. Black read a paper on "The Story of the Maine", succeeding which a collation was served, followed by dancing.

At the Annual Meeting in January, Mr. Frederick Monson gave an illustrated lecture on "Our Friends, The Indians."

The Annual Meeting and the May Meeting were held in the lecture room of the Engineering Society's building, 29 West 39th Street.

The Annual Dinner in January was attended by 414 members and guests at the Hotel Savoy, at which the President, Henry W. Vogel, presided as toastmaster.

Addresses were made by the Mayor on "His Excellency, Father Knickerbocker"; President Lawson Purdy of the Department of Taxes and Assessments on "Appreciation and Condemnation", and President John H. Finlay of the College of the City of New York on "The Future of Great Cities in the Light of History."

Membership.

On January 1, 1912, the membership was 534, which with the addition of thirty-seven new members, and one restored to membership, makes a total for the year of 572. The Society has lost sixteen members by death and resignation, and has eliminated inert matter of long standing by dropping 49 men for non-payment of dues. The net membership at the end of the year, therefore, is 506, which is really 22 effective members more than at the end of 1911.

Finances.

The actual receipts during the year have been $8 591.80 which compared with the expenditures, $6 434.26 show a cash balance at

the end of the year of $2 157.54, against which there are liabilities or bills payable of $323.75.

The difference between current receipts and current disbursements for 1912 shows an excess of the former over the latter of $1 249.04, or nine times the corresponding difference in 1911.

Inspections.

Two inspection trips were made, one in May and the other in October. The trip on Saturday, May 23, 1912, was attended by 150 members and was made by automobile through the Borough of Richmond. The trip on Saturday, October 19, 1912, was attended by 130 members, and consisted in a visit to the Hill View Reservoir of the Catskill water system. The committee on inspection has arranged for two inspection trips to be made during January or February, in 1913, to the Rapid Transit Work of the Public Service Commission, and to the City high pressure tunnel of the Catskill Acqueduct.

BOARD OF ESTIMATE AND APPORTIONMENT.

The work accomplished by the Board of Estimate and Apportionment during the year is shown by the following tabular statements:

Corporate Stock Issues.

Improvement.	Amount Authorized.
Subways and Rapid Transit	$16 549 046.90
Repaving	6 250 400.00
Street and Park Opening Fund	1 656 561.98
Docks and Ferries	1 610 557.00
Department of Bridges—Municipal Building	1 249 490.30
Grade Crossings, and Grade Crossing Commission	1 180 000.00
High Pressure Fire Service	950 000.00
Health Department, Department of Charities, Hospitals	927 500.00
School Sites and Buildings	682 970.50
Improvement of Water Supply	587 152.69
Topographical Work	368 700.00
Viaduct, Park Avenue and 42nd Street, Manhattan	350 000.00
Court, Court House Board	162 000.00
Parks, Parkways, Parkway Commission, Street and Park Lighting	144 788.96
Fire Department	60 000.00
Metropolitan Sewerage Commission	47 000.00
Corporation Yard (Manhattan)	38 000.00
Sewer Design (The Bronx)	16 050.00
Public Buildings (Miscellaneous)	7 575.00
Steam Roller and Tank Wagons (Richmond)	5 000.00
Improvement at Franklin and 3rd Avenues, The Bronx	1 500.00
Department of Street Cleaning	1 000.00
	$32 795 233.33

Assessable Improvements Authorized.

Borough.	Grading and Paving Improvements.		Sewer Improvements.		Total.	
	No.	Amount.	No.	Amount.	No.	Amount.
Manhattan	14	$172 600	10	$46 800	24	$219 400
Brooklyn	235	1 456 100	133	2 272 800	368	3 728 400
The Bronx	66	1 242 900	18	965 700	84	2 208 600
Queens	89	1 844 220	38	1 210 400	77	3 054 620
Richmond	9	21 300	9	108 200	18	189 500
Total	363	$4 737 120	208	$4 663 400	571	$9 400 520

In addition to the above, the Presidents of the various boroughs were authorized to prepare plans and specifications for 198 surface and sub-surface assessable improvements estimated to cost $5 129 300, with the understanding that as soon as this preliminary work had been completed a final authorization would be given.

Street and Park Opening Proceedings Authorized.

Borough.	Number of proceedings.	Number of streets and parks affected.
Manhattan	2	2
Brooklyn	31	62
The Bronx	26	38
Queens	28	49
Richmond	....	....
Total	87	151

Net Changes in the City Plan During the Year 1912 Expressed in Acres.

Borough.	Final.	Tentative.
The Bronx	225	0
Queens	3 070	12 984
Richmond	0	2 540
Total Acres	3 295	15 524

Area Covered by Drainage Plans Approved During the Year 1912.

Manhattan	70 acres.	
Brooklyn	2 920 "	(including 2 300 acres of territory for which a relief drainage system was provided).
The Bronx	2 460 "	
Queens	2 850 "	
Richmond	30 "	
Total	8 330 "	

Standard Testing Laboratory.

The Standard Testing Laboratory has, ever since its organization, been under the control of the Commissioners of Accounts. On January 1, 1913, it will become a function of the Board of Estimate and Apportionment.

At this laboratory are conducted the physical and chemical tests required in the inspection of all classes of material, food products, fabrics, etc., furnished in any of the Departments of the City of New York under contract, excepting the heavier physical tests required for structural material. The extent and scope of the work conducted during the year 1912 is as follows:

Total No. of Samples Received.	Complied with Specifications.	Did not Comply.	Research.	No. of Samples awaiting Analysis.
2 930	1 295	1 207	323	105

Percentage of samples analyzed that did not comply with specifications 48%

Samples which did not comply with the specification requirements were either rejected or an adequate deduction made for the deficiency. Samples awaiting analysis as shown above, consist mainly of research work, and are taken up as time and opportunity allow.

The total amount of penalties imposed upon contractors for inferior coal *alone* from January 1, to November 30, 1912, is..................................		$33 539.63
To this amount must be added a cost of coal analyses and sampling which would have to be paid in case this work was done by an outside Laboratory, viz.:		
Analyzing 56 samples at $4.............	$224.00	
Sampling and analyzing 1 070 samples at $6.............................	$6 420.00	$6 644.00
		$40 183.63

The entire running expenses of the Standard Testing Laboratory during the year, amounted to $40 471.83. From these figures it is clearly proven that this institution is self-supporting from the coal analyses alone, not taking into consideration the value of other work done here, such as the preparation of adequate specifications, technical and expert advice of every description.

At times this Laboratory has given valuable assistance to the Police Department and District Attorney, in the prosecution of criminals, by chemical analyses of materials found on the persons of offenders.

DEPARTMENT OF TAXES AND ASSESSMENTS.

Maps have been prepared showing the assessed value per front foot of normal lots having a depth of 100 feet, for the year 1913, following a plan inaugurated three years ago. The maps, showing every block frontage within the city limits, were published by the Record and Guide Co., as Section Three of the Real Estate Record and Guide, dated September 28th, 1912.

New tentative tax maps of the Borough of The Bronx, east of the Bronx River, showing the new street system, have been completed, and similar maps for the second ward of the Borough of Queens have been in progress during the year.

The records show that the assessed valuation of taxable property for the year 1912 is $8 204 862 430, while that of property exempt from taxation is $1 607 105 809, making a total of $9 811 968 239.

PUBLIC SERVICE COMMISSION.

Changes have been made at the stations and at other portions of the present subway (known as Contracts 1 and 2) in the way of

improvements, additional station facilities, etc., as shown to be advisable in the operation of so important a railroad system with its increasing traffic, and as required by the widening by the City of the roadway of some of its streets. The most important of such changes are the following:

The reconstruction of the ventilating chamber in Lafayette Street at Fourth Street, made necessary by the widening of the roadway. Work is well advanced.

The new entrance to the Fourteenth Street station from Union Square was completed and put in service.

Plans were made for the relocation of the entrance to the Twenty-third Street station on account of the widening of the roadway of that street. On the northwest corner the new entrance through the Metropolitan Life Building is now in use.

Connections are being built from the subway station to the new Grand Central Terminal, and to another New York Central building under construction at Vanderbilt Avenue. The old entrance has been removed from the sidewalk. Meanwhile, temporary stairways are maintained for use while the permanent work is in progress. The new westerly mezzanine for this station was put in service on September 10th. This is reached by two new stairways located against the building line on each side of Forty-second Street, west of Madison Avenue. The two on the south side are temporary ones, and a permanent stairway inside the building line will replace them when the new building under construction there is nearer completion.

Two kiosks and stairways for the Times Square station were removed from the east side of Broadway north of Forty-second Street, and an entrance substituted through the new building there erected partly on the roof of the subway. Corresponding changes were made in the station to accommodate this change.

The new entrance to the One Hundred and Tenth Street station (Broadway) was thrown open to traffic on January 17th.

An additional elevator at the One Hundred and Eighty-first Street station (Broadway) has been authorized, making a total of five, or an increase of from two to five in two and one-half years. Each elevator has a capacity of about 60 persons, and the additions indicate the growth of traffic at that station.

A tunnel street was excavated by the City from Broadway to the One Hundred and Ninety-first Street station. Connection to it is being made with the station, and the work is approaching completion.

Dual System of Rapid Transit.

Negotiations have been in progress between the Commission, representatives of the Board of Estimate and Apportionment, and of the Interborough Rapid Transit and Brooklyn Rapid Transit Companies, with a view to providing a comprehensive and extensive "Dual System" of rapid transit for the greater City, a part of this system to be operated by one and the remainder by the other of the two companies mentioned. Included in the scheme are the subway and elevated railroads already constructed, as well as those to be built. At the end of the year forms of contract with the two operating companies had been prepared, but had not been executed. An enormous amount of work has been done by the Engineering Department in the way of studies, investigations, surveys and designs in connection with the development of this dual plan.

Brooklyn Loop Lines.

Work on Section 9-0-1, including the Chambers Street station under the Municipal Building, is completed to a stage that makes it possible to lay the tracks throughout the whole of the loop subway in Manhattan. The completion of the basement of the building itself has not progressed so far as to permit the station finish work to proceed, but this will not prevent the use of the station should it be found advisable to begin the operation of the line before this finishing work is done.

The loop lines are part of the B. R. T. portion of the dual system. This route is the connecting line in Manhattan between the Brooklyn, Manhattan and Williamsburg Bridges. The two-track spur through Canal Street, thence over the Manhattan Bridge, is to connect with the Fourth Avenue subway in Brooklyn, which will also be operated by the Brooklyn Rapid Transit Company.

At the present terminus of the line at Park Row, plans have been made for a future physical connection with the tracks crossing the Brooklyn Bridge; also for a future extension of two tracks to Brooklyn by way of Park Row, Nassau and Broad Streets, under the East River and through Montague Street.

Fourth Avenue Subway, Brooklyn.

On October 2d contracts were let for two additional sections of work, which will continue the railroad south on Fourth Avenue from Forty-third to Eighty-seventh Streets. These sections, with the six on which work was begun in November, 1909. will make six and one-half miles of subway, extending from the Manhattan Bridge Plaza through Flatbush Avenue extension, Fulton Street, Ashland Place and Fourth Avenue to Eighty-seventh Street. This is generally a four-track structure to Sixty-fourth Street, south of which only two tracks are to be constructed on the westerly side of the avenue, leaving the easterly side for subsequent enlargement to a four-track structure. In places additional tracks are provided as approaches to underground spurs for future connections to other subways.

Fourteen stations are provided for, four of which are for express stops, and all designed for ten-car trains. The aggregate contract price is approximately $19 190 666.

Of the six sections originally contracted for, four are completed. The additional two are nearing completion. Work on these two was the last to be commenced, because it was necessary to secure private property and remove the buildings thereon. They include the extremely heavy and difficult work on Fulton Street, where the elevated railroad had to be supported temporarily; the deep cutting on Ashland Place, where heavy underpinning work was necessary, and the difficult crossing under the present Interborough subway at Atlantic Avenue. These two sections represent at least one-fourth of the contract value of the entire route now under contract.

This subway cannot be operated in full, however, until the temporary sewer which occupies the east one of the four tracks, between Atlantic Avenue and Butler Street, is removed. The removal of it is awaiting the construction of a relief sewer by the Borough authorities.

Broadway-Lexington Avenue Subway.

This was originally designed as a part of the so-called Triborough route, but under the dual plan the Broadway sections will form part of the B. R. T. system, and the Lexington Avenue sections and their extensions in The Bronx will be operated by the Interborough. The

Broadway subway will, as now planned, extend from Morris Street under Trinity Place, Church Street, St. Paul's rectory and church yard, Vesey Street, the Astor House, Broadway, Seventh Avenue, Fifty-ninth and Sixtieth Streets to the Queensborough Bridge. Provision is made for two tracks south of Park Place and four tracks north of it, the four tracks being generally placed on the same level. At Canal Street provision is to be made for a physical connection with a future subway extending east on that street.

The Lexington Avenue subway is to connect with the present Park Avenue subway at a point below Forty-second Street. It continues as a four-track subway north under Lexington Avenue, the Harlem River, and Park Avenue to One Hundred and Thirty-fifth Street, where it divides into two three-track branches; the east one known as the Westchester Branch, the west one as the Jerome Avenue Branch. On Lexington Avenue, on account of the narrowness of the street, the local and express tracks are generally carried at different levels, coming to the same level, however, in the low land south of One Hundred and Twenty-fifth Street. Where the conditions permit, the lower or express tracks are in tunnel, while the local tracks are carried in open cuts decked over during construction. In some instances, however, both pairs of tracks are to be carried in a double deck rock tunnel. Under the Harlem River the structure will consist of four steel tubes joined together and surrounded by a heavy concrete envelope. The clearance over the roof of the tunnel is to be 25 ft. at mean low tide. The structure will be built in sections in a yard, launched and floated to position and sunk to place in a trench dredged for the purpose in the bed of the river, after which the concrete envelope will be deposited.

An interesting feature of the design of the Broadway subway is the construction of the two tubes under the Astor House and St. Paul's vestry building, requiring the careful underpinning of those buildings. Extensive work in the way of underpinning other buildings along Broadway and on other streets is also required.

Where open cutting is required, it is carried on under a decking, so that the street traffic will not be delayed and the annoyance to the public and property owners reduced to a minimum. Exception is made in the case of outlying districts which are not closely built up and where traffic is light.

All stations are to be 480 ft. long to provide for ten-car trains. Efforts are being made to locate station entrances within the building lines; that is, on private property, where this is practicable and where the permission of the owner is obtained, thus removing the obstructions of the stairways from the sidewalks.

The construction of the subway involves extensive and difficult incidental work in the way of maintaining and reconstructing sewers and other sub-surface structures which are interfered with by it.

Eight construction contracts of an estimated value at the bid prices of $15 873 330.30 were let this year. These include Sections 1, 1-A, 2, 2-A and 3 of the Broadway subway, covering the route from Morris Street to the middle of the block north of Houston Street. They also include the following sections: No. 9, on Lexington Avenue, between Sixty-seventh and Seventy-ninth Streets; No. 14, which includes the Harlem River crossing, and Section No. 1 of the Westchester branch, extending from Alexander Avenue on One Hundred and Thirty-eighth Street to One Hundred and Forty-seventh Street on Southern Boulevard.

With the work let in 1911 there are now five sections under contract for the so-called Broadway line, and ten sections for the Lexington Avenue line. The estimated cost of construction of these fifteen sections at the bid prices, exclusive of track laying and other equipment, is $39 979 586.

On one of the sections, No. 6, on Lexington Avenue, between Twenty-seventh and Fortieth Streets, work was temporarily suspended on April 26th on account of changes which may be required by the dual plan.

Table showing approximate value of subway construction involved in the dual system for which contracts have been let, and the value of work during the year and the total to December 31, 1912 (this table does not include track and other equipment):

	Approximate contract price.	Work done during 1912.	Total work done to Dec. 31, 1912.
Brooklyn Loop Lines	$9 097 214	$555 415	$8 856 972
Fourth Avenue Subway, Brooklyn	19 190 666	2 912 626	14 710 286
Broadway Subway	7 768 278	1 841 096	1 841 096
Lexington Ave. Subway and extensions	32 211 308	5 766 204	6 041 544
Totals	$68 267 466	$11 075 341	$31 490 898

BOARD OF WATER SUPPLY.

Engineering Work During 1912.

During 1912, construction work was prosecuted actively on 48 main contracts on the Ashokan impounding, the Kensico storage and the Hill View equalizing reservoirs, on the 110 miles of transportation works between the Ashokan reservoir and the terminal shafts in Brooklyn and on 10 miles of pipe lines in Brooklyn and Queens. Seven contracts, amounting to $1 500 000, were awarded during the year, making the aggregate amount of contracts awarded to date about $94 000 000, upon which about $18 000 000 was earned during the year, making a total of about $62 000 000 earned to date.

Progress upon Catskill Aqueduct Construction to Brooklyn Termini of City Tunnel, in Miles.

Class of work.	During 1912.	To December 31, 1912.	To be done.
Concreting in open cut........	11.1	57.0	61
Excavating tunnel........	10.1	38.0	49
Concreting tunnel lining........	16.7	26.0	
		Total..........	110

Ashokan Reservoir.—Work essential to its utilization reached a state of practical completion with three-quarters of the contract amounts earned. Concreting in Olive Bridge dam and the dikes necessary to complete the artificial basin is completed but for closing a stream-flow opening in the former and other openings in the latter, to permit operation of the Ulster and Delaware Railroad Company's tracks during the relocation of the railroad around the reservoir.

Kensico Reservoir.—A timber flume for control of the Bronx River during construction was placed in operation; excavation for the dam was three-quarters completed, and this, together with certain substitute supply works to replace Kensico Lake, and highway work, including Rye Outlet Bridge, a reinforced concrete structure of five main spans, and a total length of 924 ft., represents 22% of the main contract. A large part of the contractor's plant was installed and the development of the quarries was well advanced.

Hill View Reservoir.—For the reservoir as a whole, construction was 60% done, excavation and embankment were both three-quarters completed, the concrete bottom and side lining commenced; while the dry slope paving was 20% finished.

Catskill Aqueduct to Croton Lake.—Excavation of the tunnel for the Hudson River crossing was completed and the tunnel waterway concreted. One thousand feet of lining was placed in the East and West shafts, 400 ft. more being required to complete both shafts. Out of a total aqueduct length of 63.2 miles necessary to convey water from Ashokan reservoir to Croton Lake, 14.3 miles were concreted, leaving but 5.7 miles to be completed. *The water-works as a whole, however, necessary to permit delivery of Catskill water into Croton Lake, was approximately 94% completed.*

Catskill Aqueduct to City Line.—The acqueduct waterway was concreted an additional 28 miles, completing almost 84 miles out of 92.3 miles to be built. All shaft excavation was completed, as was all shaft lining except that at the Hudson River pressure tunnel. At Hill View Reservoir the Uptake chamber was practically completed, the Downtake chamber foundations built, while the combined Dividing wall and By-pass aqueduct was finished with the exception of two gaps used to further the reservoir construction.

City Tunnel.—With the exception of Shaft 21 at Clinton and South Streets, to be 752 ft. deep, all 24 shafts of this tunnel, which is 17.7 miles long, were sunk to tunnel grade and tunneling proceeded from each so that there were over eight miles of rock tunnel excavation completed at the end of the year, in one-half mile of which the placing of the concrete lining had been commenced.

Of the 12.7 miles of 66-in. steel pipe and 48-in. cast-iron pipe, extending from the two terminal shafts in Brooklyn, into the Boroughs of Queens and Richmond, 10.3 miles were placed under contract and laid.

The total force in the Engineering Bureau of the Board of Water Supply, numbering 1 020 on December 25th, consisting of 285 engineers, 428 engineering assistants and inspectors, 129 clerks and 178 gagekeepers and laborers.

The maximum daily contractors' force actually at work in the field in one day exceeded 14 460, while the minimum was about 8 000. This does not include men in the contractors' camps tem-

porarily idle, nor those engaged indirectly on the work in cement mills, foundries, machine and repair shops, etc.

DEPARTMENT OF WATER SUPPLY, GAS AND ELECTRICITY, BUREAU OF WATER SUPPLY.

(Work on Extension and Improvements of Water Supply.)

BOROUGHS OF MANHATTAN AND BRONX.

During the year 1912, while the total rainfall was below the average for the past 40 years, the concentration of the heavy rainfall in the early months of the year resulted in such a large run-off that the reservoirs filled rapidly with the result that on April 8th, the water wasted over the New Croton Dam, continuing until June 25th, during which time the total waste amounted to 27.643 million gallons. While the average daily consumption has increased over that of last year the result of the water waste detection campaign is plainly shown by the fact that the average daily per capita consumption for the year has been only 104 gallons, whereas in 1910, it was 111 gallons.

Plans and specifications for the filtration of the Croton supply at the Jerome Park Reservoir site have been completed and before being advertised were submitted to a Board of Experts consisting of Messrs. Allen Hazen, George A. Johnson, Frank A. Barbour, W. P. Mason and James H. Fuertes, who approved the same and endorsed the selection of a rapid sand filter as compared to a slow sand filter. The plans and specifications were then submitted to a Committee of the Board of Estimate and Apportionment, who approved the same. This work, bids for which will be opened on January 8th, 1913, will be the largest and most important ever undertaken by the Department and will cost approximately $8 000-000, and will consist mainly of the following:

The construction and equipment of 80 mechanical filters, consisting of concrete tanks having a net filtering area of about 2.7 acres; covered concrete settling basins having an area of about 12 acres, and a capacity of about 88 million gallons; a covered concrete filtered water reservoir having an area of about 55 acres, and a capacity of about 350 million gallons; 5 concrete gate chambers; a concrete house for the preparation of chemicals; and all piping,

valves and filter equipment. The total excavation amounts to about 800 000 cu. yd. and the total concrete masonry to about 350 000 cu. yd. A considerable portion of the work is in the item for filter equipment which consists of piping, valves, strainer system, operating tables, apparatus for handling and applying chemicals, etc.

The time allowed for doing and completing this work is thirty-six calendar months, and the security required from the contractor is $1 000 000. In addition thereto a supplementary bond in the sum of $150 000 shall be furnished by the contractor prior to the acceptance of the work and continuing for six years thereafter to protect the City against any claims for infringement of patents, due to any work done or materials or processes used or installed by the contractor.

A contract was awarded for the rebuilding of those portions of the Old Croton Aqueduct where the structure has shown weakness, which work will probably not be completed until next summer.

Many extensions and improvements were made to the various pumping stations during the year, one of which was the installation of two new motors and pumps, one at each of the High Pressure Fire Service stations.

The policy of replacing the obsolete type of hydrants with the standard type, and eliminating as far as possible, the 6″ mains in the business and manufacturing districts, has been carried out during the year. On the distribution system, about 25 miles of mains of various sizes have been laid together with the necessary valves and hydrants, and approximately 18 miles of old 6″ mains have been removed, giving a total now in place of over 1 316 miles of water mains. During the year, about 1 800 standard hydrants have been set by Department men, most of which replace old types of hydrants.

The efficiency of the High Pressure Fire system has been materially increased by the installation of motor operated valves at Chambers Street and New Bowery, and at Houston Street and The Bowery, the valves being controlled by switches in the Oliver Street Station. By means of these valves, the existing High Pressure distribution system lying east of the Bowery can be divided into two systems, the mains on alternate blocks being supplied from separate feeders, by closing these valves, so that in case of a break the engine-

man at the station can determine in about one minute's time, in which the break has occurred and furnish full pressure on the other. Work on the contract for the extension of the High Pressure system south of Chambers Street and Maiden Lane has progressed rapidly, about 9 miles of mains having been laid, which is about 65% of the pipe to be laid under the contract. An appropriation of $950 000 has been granted by the Board of Estimate and Apportionment for the extension of the High Pressure system north of Twenty-third Street and a contract will soon be advertised covering the territory from Twenty-third to Thirty-fourth Streets, west of Madison Avenue.

Borough of Brooklyn.

As the safe supply which can be drawn from the Brooklyn watershed is estimated at about 150 million gallons daily and as the consumption for the first quarter of the year averaged nearly 155 million gallons daily, it became necessary to either provide for an additional supply, or else reduce the present consumption by a water waste investigation. Owing to the comparatively short useful life of any new works that would be constructed and to the high cost of pumping, it was decided to commence a house to house inspection of all fixtures; so that on July 11, 1912, the Board of Estimate and Apportionment authorized the employment of the necessary force for a period of five months, during which time it was estimated that most of the premises could be examined. The reduction in consumption due to the water waste investigation during the last six months, based on what it is estimated would have been obtained under normal conditions, has averaged 18 million gallons per day, and the total expenditure for this work has been about $22 300. The resultant cost per million gallons saved, has been $6.80, which is about 5% of the cost of water at meter rates, which in round figures is $133.

On August 15th, the City took title to the Sixth Street and Forest Park plants, which were being operated under contracts made with Silas W. Titus, dated July 15th, 1907, under which contract a minimum supply of 10 million gallons a day from the two stations was to be furnished. This department intends to operate the Forest Park plant, but proposes to dismantle the Sixth Street Sta-

tion, as the water obtainable from this plant is not satisfactory for domestic consumption. At the Jameco Station a change was made from the air lift system as operated by Contractor Titus to the direct suction system and the saving due to the operation of the plant by the City's force under the latter method was 106% based upon the present cost per million gallons. Many improvements and alterations at the various pumping stations both under contract and by the City's force, have resulted in improved and more economic methods of operation and an increased yield at some of the Stations.

In the distribution system, about 25 miles of mains have been added, together with the necessary valves and hydrants, making a total length of mains in place of about 993 miles. By replacing the smaller size mains with larger and also by the cross connections of mains, the supply in many districts was greatly improved, especially for fire protection. Due to the greatly improved water supply in the district bounded by Atlantic Avenue, Sumner Avenue, Flushing Avenue, Borough Line, Evergreen Cemetery and East New York Avenue, the Fire Insurance Exchange removed the 20% excess charge, which reduction will mean a saving of many thousand dollars to property owners in the district.

Borough of Queens.

While the average daily consumption in this Borough has increased over that of last year, there has been no difficulty in meeting the requirements of the consumers, although it was found advisable on August 21st, to start the Whitestone Pumping Station which had been temporarily abandoned in 1911, pending improvements. While the 30-inch mains connecting the first and third Wards has been laid, water cannot be pumped from one Ward to the other until the 24″ main from the Bayside Pumping Station is completed, together with the necessary improvements to the Pumping Station. The present contract with the Citizens Water Supply Co. terminated July 9th, 1912, and a new contract with that Company is now in preparation.

Owing to lack of appropriation, the contract for laying the main connecting the Brooklyn with the Queens system could not be let this year, so that this supply will not therefore be available until next year. Improvements and alterations have been made to the

various Pumping Stations and Station No. 2 has been abandoned and the building equipment and land will be disposed of as soon as practicable.

In the distribution system about 25 miles of mains have been added, making a total now in place of about 206 miles.

Borough of Richmond.

In the beginning of the year the supply available for the consumers was inadequate to meet the demands, so that the temporary plant on Southfield Boulevard was put in operation and although the addition to the supply was slightly less than 1 million gallons daily, the situation was immediately relieved and for the first time in many years there has been no necessity during the summer months of stopping the use of water for sprinkling purposes. The new pumping station building at Grant City has been practically completed and the consent of the Borough President was obtained to place the chambers for the auxiliary pumps for Grant City Station within the Street limits, thus making it possible to actively prosecute the development along the Southfield Boulevard. On June 3rd, the State Water Supply Commission approved the purchase of lands for the auxiliary stations to be used in connection with the Southfield Boulevard developments. Six new wells were connected up at the Clove Pumping Station and about seventeen observation wells were driven by Department force in the vicinity of the Southfield Boulevard in order to note the fluctuations in the ground water levels due to pumping. Extensions to the distribution system consisted in the addition of about 28 miles of mains of various sizes, giving a total now in place of about 230 miles.

During the year, for the extension and improvement of the systems in all Boroughs, about 55 contracts, exclusive of those for supplies, amounting to about $2 100 000, were awarded.

BUREAU OF GAS AND ELECTRICITY.

The lighting of the Greater City has been extended with the improved forms of lighting, utilizing to the utmost the tungsten lamp, where available, in suburbs, and reinforcing the arc lamps on main avenues. The system of distribution of these lamps has been under the improved system of distribution adopted about four or five years

[illegible] the results of which now begin to show in the greater uniformity of illumination in the streets.

In the Borough of Manhattan the development has been almost [illegible] with arc lamps [illegible] and placing them in the improved system.

In the Borough of Brooklyn, both arc and tungsten lamps have been used very largely in improving the present illumination, and an improved system of lighting is now nearly completed on the Ocean Parkway.

In the Borough of the Bronx, while a number of arc lamps were used, the largest extension in the lighting was in the way of tungsten units.

In the Borough of Queens, considerable progress has been made by the extension of the tungsten lighting system, the number of arc lamps in this borough remaining about even.

In the Borough of Richmond, the principal improvement has been the beginning of the St. George Terminal lighting with both tungsten and arc lamps, extending down to the ferry houses, and covering several streets in either direction.

In the Greater City, the increased number of lamps and the increased candle power are given in the following table, which compares the results of 1911 and 1912:

	Dec. 31, 1911		Dec. 31, 1912	
	No. of lamps	Est. C. P.	No. of lamps	Est. C. P.
Electric	[illegible]	[illegible]	[illegible]	[illegible]
Gas	[illegible]	[illegible]	[illegible]	[illegible]
Naphtha	[illegible]	[illegible]	[illegible]	[illegible]
Total	[illegible]	[illegible]	[illegible]	[illegible]
Increase			[illegible]	[illegible]
Per cent. increase			[illegible]	[illegible]

During the summer, elaborate experiments were made in a trial installation of high candle power tungsten lamps and higher candle power gas lamps for use on side streets, principally in the Borough of Manhattan. The results were very satisfactory and it is hoped that during the coming year a start may be made on these lines. This lighting requires a different lamppost and different spacing from the present single gas mantle system.

Elaborate experiments are also going on now in trying to find a satisfactory flame lamp to take the place of the standard enclosed lamps now on the main avenues. So far, the results have been very encouraging, and it is hoped that the lamp will be completely perfected during the coming year, so that it may be adopted within a reasonable period.

The lighting in public buildings has been as heavy as usual, and the work of approving plans and specifications made by, or for other Departments has been going at more than the usual rate, some 650 to 700 of these projects having been passed during the year 1912.

The following table gives the statistics of the work done in the Electrical Inspection Division of this Bureau:

INTERIOR ELECTRICAL INSTALLATIONS:

Applications received.................................... 74 096
Certificates issued.. 66 772

These applications covered:

1 423 236	Incandescent lamps,
6 212	Arc lamps,
24 308	Motors,
2 612	Electric Signs,
1 180	Moving Picture Machines,
13 908	Miscellaneous appliances.

ON EXTERIOR ELECTRICAL CONSTRUCTION, BOTH OVERHEAD AND UNDERGROUND.

55 620 applications were made, and
55 412 permits issued.

This covered the erection of 7 800 poles, on which 7 265 miles of overhead conductors were strung. In addition, 119 miles of underground trench, carrying 548 miles of ducts and 163 678 miles of underground conductors were laid.

198 192 inspections were made. Violations were issued to the extent of 11 604, and of these, 10 376 were cleared.

During the year, 2 404 operators of moving picture apparatus have been examined. In 1911, 1 025 picture operators were examined, which shows the heavy increase in this work.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

Queensborough Bridge.

A contract was completed during the year for the electrical equipment of the outer trolley tracks, thus enabling the Third Avenue Bridge Company to operate its cars over the bridge, which operation began on January 24, 1912. A contract for the construction of stairways and elevators in the Queens Anchor Pier was sufficiently completed to permit the use of the stairways on July 22nd and the elevator service on October 23, 1912. A contract for the construction of a shelter house on the Queens Plaza was let on November 13th, 1912, at a price of $4 450.

Willis Avenue & Third Avenue Bridges over the Harlem River.

A contract was let July 5, 1912, at a price of $31 840. for the electrical equipment for operating these two bridges. This installation will permit the abandoning of the present steam boiler plants at each of these bridges.

Miscellaneous.

Many of the bridges under the jurisdiction of this Department were beautified in appearance during the year by the planting of grass plots, flower beds and trees on spaces that were not used for traffic or operation purposes.

Municipal Building.

The general contract for the erection of the superstructure is about 96% completed. All the granite has been set, and the exterior of the building presents a finished appearance, except for the erection of the figure on the top. A contract for furnishing and installing the elevators was left on May 24th, 1912, at a price of $465 400. This contract is about 10% completed at the site, although a large portion of the material is being manufactured and will be ready for early shipment and installation. A contract for the interior finish of the Building was let on July 11, 1912, at a price of $3 058 135.53. The material needed for this contract is being manufactured and a considerable amount of the material has already been placed.

DEPARTMENT OF DOCKS & FERRIES.

The wharfage room created by the Department previous to 1912 was	280 790	lin. ft.
The net wharfage created during the year 1912	1 500	" "
Total present created wharfage room	280 290	" "

Of the available wharfage room in the various boroughs, the City now owns about

80 per cent. in the Borough of Manhattan.
10 per cent. " " " " Brooklyn.
2 per cent. " " " " Bronx.
1 per cent. " " " " Queens.
4 per cent. " " " " Richmond.

(Brooklyn & Queens estimates are exclusive of Jamaica Bay). It also owns most of the islands in Jamaica Bay, constituting about 60 per cent. of the total waterfront of that locality.

Chapter 778 of the Laws of 1911 provides that private terminal owners may be incorporated to operate terminals under conditions of public control and approval, through the Department of Docks & Ferries. Definite plans have been submitted by the Degnon Improvement Company to collaborate with the Dock Department for the construction of an extensive freight terminal at Dutch Kills, Borough of Queens. These plans are now before the Board of Estimate & Apportionment. Plans and reports have been submitted to the Board of Estimate & Apportionment for the organization of the South Brooklyn waterfront from Brooklyn Bridge to Sixty-sixth Street. These have finally culminated in the adoption by the Board of Estimate & Apportionment of plans for a terminal marginal railroad which will serve as a backbone to the commercial and industrial waterfront development of this entire section. A new plan for improving the waterfront to comprehend two nine-hundred-foot piers, has been adopted for the Gansevoort Market Section on the North River and numerous studies for piers 1 000 feet and over in length have been prepared and estimates made for providing accommodations for the longest steamships between West Thirty-eighth and West Fifty-eighth Streets, North River, Borough of Manhattan.

The construction work of the Department has comprised during the past year bulkhead or sea wall construction at the foot of Cort-

landt Street, at the Corlears, Yorkville and Blackwell Sections on the East River, at the East Ninetieth Street Section and at the East One Hundred and Twenty-third Street Section on the Harlem River. In the aggregate the total wall built during the year is 740 lin. ft.

The West Fifty-fourth Street Pier has been extended to the established pierhead line. New piers have been built at West One Hundred and Thirty-fifth and at West One Hundred and Fifty-sixth Streets, North River; at the foot of East Tenth Street and East One Hundred and Third Street on the East and Harlem Rivers and platforms at the foot of Garrison Avenue, Bronx River; at Main Street, Westchester Creek and between Twenty-eighth and Thirtieth Streets, South Brooklyn. The freight shed on the pier at Thirty-third Street, South Brooklyn, has been completed. This shed is 1 593 ft. long.

In conjunction with the Commissioner of Parks Riverside Park is now being extended outshore a varying distance from 100 to 200 ft. between West Seventy-second and West One Hundred and Twenty-ninth Streets. The material for filling in the area is being supplied without cost by the contractors engaged in building the high pressure water tunnel in connection with the Catskill Aqueduct under Manhattan. The total area of land reclaimed during the year 1912 in this work is estimated at about 74 acres.

The total area of filled-in land made during the year 1912, including that at Riverside Park, is about 132 acres.

Probably the most important work begun during the year is dredging the channel from Barren Island to Mill Basin, Jamaica Bay, begun December 4, by the building of a sod embankment to retain the filling in the northerly end of the work. Dredging was begun on December 17th, with two large suction dredges working near the northerly end of the work continuously until forced to shut down by severe weather. When this work is completed an 18-ft. channel 500 ft. in width will be provided, extending from the sea to the entrance of Mill Basin and the dredged material will have formed an area of filled-in land from five to seven hundred feet in width and about a mile and a half in length, inshore of the established bulkhead line. This is as far as the Jamaica Bay improvement can go for the present as the new plan has not been prepared north of the entrance to Mill Basin and the filled area cannot be

connected with the mainland until a channel is provided in Mill Basin which will permit the closing of Mill Creek and the extension of Flatbush Avenue. In the meantime the City will doubtless receive some revenue from summer cottages, tent privileges, etc., along the filled-in area adjoining the Main Channel.

The price at which this dredging is being done is less than the maximum amount which the United States Government has agreed to reimburse the City for the work, and the dredging will, therefore, cost the City nothing but the inspection and supervision. Money will, therefore, be available for another contract north of Mill Basin as soon as this part of the new plan has been approved. Payments are made by the government to the City on monthly estimates.

During the year a system of collecting data to show the amount of tonnage handled in and out of the Port of New York has been inaugurated. These records show that for the year 1912 about 57 million tons of freight were handled over the docks and wharves under the jurisdiction of the City.

At the Thirty-ninth Street, South Brooklyn, Terminal, a new permanent ferryhouse with all appurtenances is in course of construction at a cost of about $154,000.

A ferry operated by private enterprise has been established between Bay Ridge Avenue, Brooklyn, and St. George, Richmond. Also between Clason Point, Borough of The Bronx, and College Point, Borough of Queens.

The ferries from Wall and Catherine Streets, Manhattan, have been abandoned by the Union Ferry Company. It is intended to adapt the ferry terminals at these points to commercial use.

The recreation centres have been patronized to a greater extent than before. The Parks & Playground Association have supplied teachers to instruct the children in folk dances, etc., thus materially increasing their enjoyment.

The floating plant of the department has been kept in a high state of efficiency and repair, particularly the ferryboats, by making the major part of these repairs at the West Fifty-seventh Street Yard, resulting in a great saving in cost.

In the early part of the year the Bureau of Supplies was established to concentrate and systematize the handling of the sup-

plies of the Department. Such concentration of this improved routine under a special staff has done much to improve the methods of recording, checking and auditing of supplies as well as in the department's keeping less stock in hand.

The receipts for dock and slip rent during the year 1912 amounted to $4 328 453.28, an increase of $149 438.13 over 1911.

The receipts for ferry rent and franchises amounted to $229-549.48, an increase over 1911 of $11 950.87.

The receipts from the Municipal Ferries during the year 1912, amounted to $967 911.44, an increase over 1911 of $57 139.50.

DEPARTMENT OF PARKS.

Boroughs of Manhattan and Richmond.

The new street along the westerly side of John Jay Park, between Seventy-sixth and Seventy-eighth Streets was paved, the sidewalks with granolithic pavement, and the roadway (some 1 360 sq. yds. in area) with asphaltic concrete. This work also embraced new curbstones and the installation of proper drainage.

Work on the general improvement of John Jay Park, begun about the first of September, has continued to date. The work has embraced earth and rock excavation, masonry retaining walls, drainage and water supply, gravel walks, playground construction, etc.

The work of installing an efficient water supply system in Central Park, begun some years since and prosecuted whenever funds were available, was taken up again this year, during which nearly 22 000 running feet of cast and wrought iron pipe have been laid.

This work also embraced the setting of valves, stop-cocks, fire and flush hydrants, street washers and drinking fountains.

During the year a beginning was made on the construction of a pavement for the Central Park Drives, capable of withstanding automobile traffic, which the old pavement could not do.

A bituminous pavement on a concrete foundation was laid on the West Drive, from Sixty-sixth to One Hundred and Second Street. This covers an area of nearly 50 000 sq. yds. and necessitated the excavation and removal of nearly 13 000 cu. yds. of the old surfacing material from the road.

A beginning was also made on the work of replacing with a permanent structure the old timber bulkhead wall of the Harlem River Driveway, known as the "Speedway."

During the past summer, work was started on a rubble concrete bulkhead wall to take the place of a section of the wooden structure which had fallen into the river, and this work is still under way. Upon the completion of this contract there will have been built about [illegible] running feet of new bulkhead wall.

The park plots in the center of Seventh Avenue, between One Hundred and Tenth Street and the Harlem River were last year placed under the jurisdiction of the Commissioner of Parks for Manhattan. During this year these plots have been provided with a water supply, the curbs have been brought into good condition either by furnishing and setting new or by redressing and resetting the old, and the ends of the plots have been paved with granolithic pavement.

A new [illegible] vitrified pipe sewer in a concrete casing was laid from the New Croton Station west of the Old Reservoir, opposite Eighty-first Street, to the existing sewer from the Swedish School House, a distance of [illegible] feet.

During the year the asphalt roadway pavements under the jurisdiction of the Commissioner of Parks for Manhattan were kept in repair so far as the funds applicable to this purpose were available. This embraced the laying of about [illegible] sq. yds. of new pavement, mostly in small patches.

Borough of The Bronx

The work of construction during the year [illegible] has embraced the following:

Bridge and causeway [illegible] between Hunter and Twin Islands, Pelham Bay Park.

[illegible] Van Cortlandt Park.

Comfort Station in Van Cortlandt Park.

Comfort Station in [illegible] Park.

Comfort Station in Pelham Bay Park.

[illegible] Pelham Bay Park.

[illegible] Bronx Park.

Road in Bronx Park to connect with roads in Botanical Garden.

Wrought iron and concrete boundary fence around Crotona Park.

Tree planting on Grand Boulevard and Concourse, about 75 per cent. completed.

Extensive road re-surfacing, using 12 000 cu. yd. road gravel.

Asphaltic paving of portions of Bronx and Pelham Parkway.

Improvement of Broadway side of Van Cortlandt Park.

Filling and grading portions of McComb's Dam Park.

In the Zoological Park, there have been completed:

- The Eagles' Aviary,
- The Zebra House,
- The Pelican House,
- Addition to Rocking Stone Restaurant,
- Rock excavation in Service Yard.
- In progress, and well under way, a power plant and workshop building, and a public service building.

In the Botanical Garden, there have been completed:

- A range of greenhouses,
- A set of museum cases in the Museum Building.
- In progress, and nearly completed: A granite wing wall and flight of granite steps; a concrete shelter building; a wrought iron and granite boundary fence.

DEPARTMENT OF PARKS.

Borough of Brooklyn.

McCarren Park, Plot No. 1.—Construction of park and playgrounds; erection of playground apparatus in playgrounds.

McCarren Park, Plot No. 2.—Construction of park and playgrounds.

Bushwick Playgrounds.—Construction of playground; erection of shelter house and comfort station; erection of playground apparatus.

Red Hook Playground.—Erection of shelter house and comfort station; erection of playground apparatus.

McKibbin Playground.—Erection of shelter house and comfort station; erection of playground apparatus.

[illegible]

[illegible] walks [illegible]

[illegible] first part of laboratory [illegible]

[illegible] new water supply system [illegible] of Plaza at Fifteenth Street [illegible]

[illegible]

Fort Greene Park.—Reconstruction of drainage system and walks.

Highland Park Extension.—Erection of comfort station.

Borough Hall Park.—Reconstruction of walks.

Seaside Park (Dreamland).—Cleaning up debris, etc.

Eastern Parkway Extension, Bay Parkway, Bay Ridge Parkway, Shore Road, Lincoln Road, Plaza Street, Dyker Beach Drive to be resurfaced with macadam asphalt binder.

In addition to the work contemplated for 1913, as above mentioned arrangements have been made by this Department with the contractors for sections 1 and 2, Route 11 B, Fourth Avenue Subway, Borough of Brooklyn to furnish and place, without cost to the City approximately 500 000 cu. yd. of the surplus excavated materials back of the sea-wall, which has been completed along the Shore Road, between Bay Ridge Avenue and Ninety-second Street, Borough of Brooklyn.

Brooklyn Institute of Arts and Sciences.—Erection of superstructure; Children's Museum, Bedford Park.

Brooklyn Botanic Gardens.—Erection of second part of greenhouses; Construction of roadways, walks, etc.

PARKS, QUEENS.

Borough of Queens.

Number of parks in the Borough in 1911....	15
Total acreage, 1911........................	688.92
Number of parks in the Borough on Dec. 31, 1912.................................	20
Approximate area, Dec. 31, 1912............	1 000 acres

During the year 1912 plans have been prepared for the laying out and developing of Rainey Park, on the East River opposite Blackwell's Island, Borough of Queens, involving an estimated expenditure of about $25 000.

Plans and specifications for the development and improvement of Linden Park, in Corona.

Plans and specifications prepared for the laying out and improving of Kissena Lake Park, in Flushing, involving an estimated expenditure of about $80 000.

Plans and specifications for the development and improvement of [illegible] Park in Queens.

Partial plans prepared for the development of Telawana Park as a seaside park on the Rockaway Peninsula.

Plans and specifications for the improvement and development of the Administration section of Forest Park and a first part of the construction for the Administration Building completed therein.

Plans and specifications for a comprehensive system of automobile and carriage roadways through a large portion of the above park, and contract forms and specifications prepared for the same, about to be let for their construction.

Also plans and specifications and contract drawings for the regrading and construction of two baseball grounds therein.

Approximate estimated cost of the Forest Park improvements being $[illegible].

The improvement of Rainey Park above mentioned involved the construction of a sea-wall of solid concrete on subaqueous foundations, the length of which is about 600 ft., protecting the shores of this park from the rapid currents of Hell Gate.

Also the extensive regrading of about four acres and the backfilling of the sea-wall, as well as the construction of a proper masonry comfort station and band stand and the construction of iron picket fences.

The improvement of Linden Park involved the raising of the grade of the entire surface of the park, three acres; the pumping out and cleaning of the lake therein and the construction of concrete approaches to the latter with rubble protections for the entire remaining shore line; the construction of concrete and asphalt block walks, iron fencing and masonry band stand, and arrangements for artificial water supply for the lake.

Forest Park.—Changes of roadways involved the construction of steel and masonry bridges and the partial reconstruction and improvement of an eighteen-hole golf course over a highly irregular surface and the establishment of a series of artificial lakes, varying from twenty-two to five acres in extent;

Also the felling and disposal of about ten thousand chestnut trees, killed by the chestnut blight; the sawing into merchantable lumber of the felled timber, which necessitated the installation of

a typical logging camp and saw mill, unique in the experience of large cities. It has been proved that the character of the blight, which begins at the top of the timber, renders it possible to utilize the main and more valuable portions of the trees for railroad ties, sea coast board-walk lumber, and for telegraph poles, fence posts, surveyors' stakes, and numberless other materials of equal value, some of it being valuable for such artistic purposes as picture frames.

The plans for the development of Kissena Lake Park involve the dredging and utilization of 35 to 40 acres of swamp land, heavily timbered, and the creation of uplands scattered through it.

The construction of bathing pools, masonry boat house, bridges, culverts, macadamized roadways, a comfort station and park house of masonry, lay-out of athletic track, and extensive fencing and regrading.

The plans for the improvement of Rockaway Park, not above mentioned, involve the construction of about one mile of board walk on reinforced concrete, slightly elevated foundations, and the care and maintenance of several miles of superficially macadamized or gravelled side streets, and the flagging, curbing and maintenance thereof.

The development of Telawana Park involves park treatment, on the basis of a purely seaside development, of a neck of sand a mile long by about half a mile wide, fronted on either side by Bay and Ocean, and the arrangement and construction thereon of seaside sanatoria and hospital buildings, among the largest in the country, as well as the construction of elaborate masonry bath houses and buildings for park uses, capable of accommodating twenty-five to three hundred thousand people.

The acquisition of the land alone for this park cost the city upwards of a million and a quarter of dollars.

DEPARTMENT OF FINANCE.

The engineering activities of the Department of Finance are conducted by the Bureau of Investigation and Statistics, and embraces the investigation of plans, specifications and estimates of cost for work proposed to be done under contract by any of the City Departments.

These investigations for the year 1913 have involved proposed contracts work aggregating $[illegible].

Very large savings are then effected by changing specifications so that ample competition is provided, with large reductions below the original estimate of cost.

METROPOLITAN SEWERAGE COMMISSION

Since April 1910, a large part of the work done by this commission has consisted of the preparation of plans for main drainage and sewage disposal for New York City. In this time, the commission has published two bound volumes of reports aggregating about 1,000 quarto pages, including various maps, diagrams and tables. In addition, five printed reports on special topics have been issued. Most of these publications have appeared in the last year.

For the purpose of study, the city has been separated into four divisions. The land whose drainage is naturally tributary to Jamaica Bay is known as the Jamaica Bay Division. The commission has proposed a system of intercepting sewers which will practically encircle Jamaica Bay and lead to two points where purification works will be located. One of these points is near Far Rockaway and the other near Barren Island. The purified sewage will be passed into the neighboring waters.

For Northern Queens most of the sewage would be carried to the vicinity of College Point and there so treated for the removal of impurities as to permit the effluent to be discharged into the deep and swiftly-flowing waters of the Upper East River.

For the eastern part of the Bronx, sewage treatment works would be located near Clason Point.

The sewage of the northeastern part of Manhattan and that part of the Bronx which is naturally tributary to the Harlem River and East River in the vicinity of Hell Gate would be carried to Ward's Island by lines of intercepting sewers. The sewage would be screened and settled at Ward's Island and the effluent discharged into the deep, rapidly-flowing waters of Hell Gate.

The sewage produced in the northern part of the Borough of Richmond would be collected to five principal outfalls situated near the shores of the Narrows and the Kill van Kull. After brief se-

tlement and screening, the sewage would be discharged into the neighboring waters.

Printed reports, accompanied by maps giving the approximate location of the intercepting and collecting sewers and purification works have been issued to cover all the foregoing work. Preliminary estimates of cost accompany the reports. The commission invites discussion of these plans. The work has all been done in co-operation and with the assistance of the local sewer bureaus.

The final work to be done by the commission is now in hand. It consists of the making of plans for the disposal of the sewage of that part of Manhattan Island whose drainage naturally flows to the Hudson River and Lower East River and that part of Brooklyn whose drainage is tributary to the Lower East River and Upper New York Bay. Owing to the very large volume of sewage to be dealt with, to the thoroughly built-up state of the land, to the high cost of property and to the necessity of avoiding odors, it will not be possible to purify this sewage sufficiently in the territory where it is produced to permit the effluent to be discharged in the vicinity. The sewage will probably have to be taken away from the Lower East River territory to some distant point for disposal. It is expected that a report on this subject will be published by the commission in the near future. The problems involved in this work are peculiarly difficult and in its endeavor to arrive at a wise conclusion, the commission has secured the services of a number of eminent European experts in sewage purification. One of these, Prof. W. E. Adeney of Dublin, Ireland, has reported on the question of oxygen in the harbor waters. Dr. Gilbert J. Fowler of Manchester, England, and Mr. John D. Watson of Birmingham, England, have advised the commission as to the extent to which the waters of New York Harbor can be safely employed for the absorption of sewage and the availability of various methods for the purification of sewage, so that the absorptive capacity of the harbor for sewage shall not be exhausted and the water become black and offensive.

Within the last year, the commission has proposed a standard of cleanness for the waters of New York Harbor and has recommended that the pollution of the waters should not fall below this standard. This work was done partly at the request of the Board of Estimate and Apportionment. In formulating the standard, the commission

drew not only upon its own intimate knowledge of the harbor and the conditions of sewage disposal in this vicinity, but secured the advice of eight sanitarians of national eminence in the various professions of engineering, chemistry, biology and health administration. The reports of these experts have been printed in full and distributed to those engineers and others who have official use for them.

Beside the five commissioners, four of whom are engineers, the working force of the commission contains three engineers, a chemist and a bacteriologist.

The office of the commission is open at all times and one of the commissioners can be seen there at any time by anyone connected with the city government. On the recent occasion of the visit of Messrs. Fowler and Watson, an informal reception was held at the commission's office at which all the boroughs were represented by their engineers and principal assistants concerned with sewerage matters.

PAVEMENTS.

During the past year new pavement has been laid in the various boroughs as contained in the following table, the length in each case being indicated in miles:

	Manhattan.	Brooklyn.	Bronx.	Queens.	Richmond.	Total.
Sheet asphalt........	27.01	51.72	4.70	2	......	85.43
Asphalt block........	3.24	3.20	3.71	4	......	14.15
Wooden block.......	6.52	3.29	0.24	1	0.29	11.34
Granite block........	11.97	9.65	0.93	3	5.52	31.07
Medina sandstone....	0.11	....	......	....	0.33	0.44
Rock asphalt.........	0.10	....	......	....	......	0.10
Rock asphalt block..	0.10	....	......	....	......	0.10
Iron slag.............	......	0.39	......	....	2.06	2.45
Macadam............	......	0.48	......	....	......	0.48
Bituminous pavement..............	......	....	3.50	....	......	3.50
Asphaltic concrete..	......	....	......	90	......	90.00
Vitrified brick.......	......	....	......	....	4.62	4.62
Concrete.............	......	....	......	....	0.40	0.40
Totals.........	49.05	68.73	13.08	100	13.22	244.08

The total mileage of pavement in the various Boroughs as reported at the close of the year, is as follows:

	Manhattan.	Brooklyn.	Bronx.	Queens.	Richmond.	Total.
Sheet asphalt..........	246.27	468.46	46.48	....	0.44	761.65
Asphalt block..........	58.64	30.63	59.86	....	9.52	153.75
Wooden block..........	25.45	6.63	8.87	....	8.18	39.18
Granite block..........	97.	132.19	40.31	....	5.52	275.02
Medina sandstone.....	0.26	7.29	0.24	....	0.33	8.16
Rock asphalt..........	0.10	....	....	....	....	0.10
Rock asphalt block....	0.10	....	....	....	....	0.10
Iron slag	....	2.58	1.54	....	2.06	6.18
Macadam..............	4.81	103.19	....	....	186.63	294.63
Bituminous pavement	....	....	3.99	....	12.15	16.14
Asphaltic concrete	....	....	....	....	....	....
Vitrified brick.........	....	1.49	0.49	....	4.62	6.60
Concrete...............	....	....	....	....	0.40	0.40
Belgian Trap, etc......	16.04	21.79	0.17	....	....	38.00
Totals..........	443.67	774.25	157.09	....	224.85	1 599.86

Borough of Manhattan.

All of the pavements laid in Manhattan during the year, 1912, were laid on 6-in concrete foundations. The granite block is of the improved type, the blocks being cut with 2-in. surface and laid with a maximum joint of ½ in. Some have been laid with what is known as the special improved granite with ⅜-in. joint, the blocks having a head with permissible variation of only ¼ in. from the plain surface.

In order to obviate as much as possible future disturbances of new pavements, public service corporations have been directed to overhaul their sub-surface structures in advance of re-paving. Accordingly, 85 miles of gas mains, steam mains, and electric conduits with the necessary house connections, manhole connections and other sub-surface connections, have been re-laid or repaired.

Second Avenue has been re-paved between Houston and East Twenty-third Street with short stretches of different types of pavement for experimental purposes, in order to observe their relative values under an approximately constant traffic. In this area there have been laid thirteen different varieties of wood block, both short and long leaf pine, and hard wood, variously treated as to type and quantity of oil; several variations of sheet asphalt including the use of close and common binder and rock asphalt surface; three types of asphalt block; two varieties of Medina sandstone—the regular blocks and small cubes; and a section of improved granite block with cement-grouted joints. It was planned to include also

a sample of creosoted block and the foreign "Durax" pavement. No bidders could be found, however, to undertake these two latter types. It is intended to make regular observations in order to determine the wearing and other qualities of the above mentioned sample pavements.

In all about fifty miles, or nearly twelve per cent. of the paved roadways of Manhattan have been repaved.

Repairs to granite pavement have been made by day labor. The maintenance of sheet asphalt, asphalt block, and wood block pavements has been carried out by contract.

During the year 191[illegible] an average of over [illegible] permits per month for street openings have been issued by the permit division of the Bureau of Highways; an increase over previous years due to the constantly increasing amount of rebuilding in the city.

The division of sidewalks has been actively employed in the removal of sidewalk encumbrances as well as the special work necessitated by the clearing of obstructions from sidewalks in certain congested streets, notably Broadway, which has been cleared of all obstructions from the Battery to Fifty-ninth Street.

The work of widening the roadway of the busier thoroughfares undertaken during the previous year, has been continued: Fourteenth Street from Second Avenue to Eighth Avenue, and Second Avenue from East Twenty-third to Houston Streets have been widened by setting back the curb and re-paving the entire roadway, all encroachments on the sidewalks or beyond the building line having been removed. About 21½ miles of streets have been included in the various orders of the Board of Estimate & Apportionment for this work, and about 75% of the work has been completed.

The widening of roadways has involved the changing of numerous subway and elevated railway entrances and stairways. Wherever possible, subway entrances have been placed inside of the adjacent buildings. Negotiations have also been carried on with the Public Service Commission to determine locations for new subway entrances which will be mutually advantageous to the transportation company and the public using the sidewalks.

It has been proposed to change the grade of Park Avenue at Thirty-fourth Street so as to provide a continuous roadway at a moderate grade on both sides of the avenue; to open Thirty-third

Street across Fourth Avenue, to eliminate excessive grades on Thirty-fourth Street and to permit the construction of a crosstown subway in Thirty-fourth Street.

The contract for the construction of a tunnel from Broadway to the One hundred and Ninety-first Street Subway Station has been supervised.

Borough of Brooklyn.

In addition to the foregoing statement of mileage of pavements laid during the year, about 40 miles of streets were regulated, graded and curbed and sidewalks laid.

Borough of the Bronx.

The treatment of macadam and earth roads with bituminous materials, which was organized in 1911, has been continued through the year 1912, with great success. The majority of the macadam roads in this Borough have received their second application, and now present a surface much resembling an asphalt pavement. Where the traffic is moderately light, this treatment has proven particularly advantageous, and is without a doubt the most economical and efficient maintenance. It not only acts as a dust layer but possesses exceptional binding qualities. In the treatment of earth roads, the oil has been most effective.

A large street area has been re-paved with re-dressed granite blocks. Several large contracts have been begun or completed for re-paving with improved granite blocks, with grout joints. A considerable amount of bituminous concrete has been laid during the year as temporary pavement with generally satisfactory results.

The decrease in macadam pavements as compared with last year is due to their being replaced with permanent pavement.

About 9.6 miles of streets and avenues have been regulated, graded, etc.

Borough of Queens.

In conjunction with the permanent pavement paid for by assessment and the work paid for out of the re-paving fund, the Board of Estimate and Apportionment authorized the re-paving of 90 miles of water-bound macadam with asphalt concrete pavement. The work was started during April and has been completed with

the exception of one section which has been delayed owing to the dilatory tactics of public service corporations.

BOROUGH OF RICHMOND.

In addition to the foregoing statement of paving work done in this Borough, general heavy repairs to 6.3 miles of macadam pavement, with new stone, water bound; 3.5 miles of macadam pavement, with bituminous binder, and 0.1 of a mile of macadam pavement, with old and new screenings, have been made.

Surface treatment repairs with Gritz and Tarvia have been made to 32.9 miles; repairs with ¾-in. stone and asphalt binder to 10.2 miles, and repairs with ¾-in. stone and tar binder to 7.1 miles of streets.

SEWERS.

During the year 1912, the lengths of sewers and the number of receiving basins constructed in the various boroughs are as shown in the following table, the sewer lengths in each case being indicated in miles.

Character.	Manhattan.	Brooklyn.	Bronx.	Queens.	Richmond.
	Miles.				
Brick and concrete sewers	0.640	32	2.1	3.85	2.36
Pipe and culverts	0.805		14.2	6.38	4.96
Totals	1.445	32	16.3	10.23	7.32
Receiving basins	17	442	74.0	82.00	81.00

The total number of receiving basins and mileage of sewers in the various boroughs at the end of the year 1912 is as follows:

Character.	Manhattan.	Brooklyn.	Bronx.	Queens.	Richmond
	Miles.				
Brick and concrete sewers	406.38	625	69	......	13.47
Pipe sewers and culverts	111.43		251.6	......	70.78
	517.81	625	320.6	......	84.25
Receiving basins	6 425.00	11 700	3 541.0	......	[illegible]85.00

Borough of Manhattan.

During the year 13 contracts for sewers were completed, at a total cost of \$76 800. Eight contracts for sewers, aggregating an estimated cost of \$73 947, were under way at the end of the year.

In the matter of sewer cleaning, over 23 000 cu. yd. of deposit have been removed from receiving basins, at a cost of \$1.80 per cu. yd. 154.5 miles of sewers have been cleaned during the year, involving the removal of about 4 000 cu. yd. of material.

A campaign has been conducted to prevent the discharge of steam, hot water, and gasolene into sewers, and also to prevent the discharge of warm air from boiler rooms up through gratings in sidewalks.

Studies have been made of the necessity for treating the sewage of the Borough before discharging it into the harbor, and of the desirability of reconstructing the entire sewer system of the Borough.

General directions have been issued for establishing gauge stations in various typical sewers of the Borough in order to determine the quantity of both dry weather and storm weather flow into the sewers. Many samples of sewage have been taken and tested. The harbor waters have also been tested to determine the degree of pollution.

Borough of Brooklyn.

There are four purification plants in this Borough. 88½ miles of 6-in. house connections have been built under the jurisdiction of the Bureau of Sewers since its organization.

Borough of the Bronx.

During the year 1912 plans and specifications have been completed for three large sewers, aggregating in length 25 450 ft., to drain an area of 19 151 acres, at an estimated cost of \$784 000.

The most important sewer construction during the year has been the White Plains Road outlet sewer, now about three-fourths completed, and, when finished, will drain an area of about 7 500 acres, comprising the greater part of the district east of the Bronx River from Long Island Sound to the City Line, at a cost of \$621 000.

During the year 11 sewerage districts have been planned, aggregating in area 2 7[illegible] acres.

STANDARD FORM OF SEWER CONTRACT AND SPECIFICATIONS.

In the latter part of 1911, the Board of Consulting Engineers organized a committee consisting of the Chief Engineers of Sewers for the various Boroughs for the purpose of preparing a standard form of sewer contract and specifications for use in the various Boroughs.

This Committee was organized on December 4th, 1911, and has held frequent meetings at the office of the Chief Engineer of Sewers, Borough of Manhattan, and, after a full and free discussion, completed its labors in September, 1912, and on November 7th, 1912, presented the result in printed form to the Board of Consulting Engineers for its consideration.

BUILDINGS.

BOROUGH OF MANHATTAN.

The following tabular statement shows the number of new buildings, and estimated cost, for which plans have been filed during the year 1912:

Classification.	Number of buildings.	Estimated cost.
Dwelling houses, estimated cost over $30 000	17	$1 388 100
Dwelling houses, estimated cost under $30 000	59	94 000
Tenement houses	179	30 852 600
Hotels	12	7 185 000
Stores, lofts, etc., est. cost over $15 000	30	476 000
Stores, lofts, etc., est. cost under $15 000	27	158 700
Office buildings	48	30 591 000
Manufactories and workshops	42	4 708 770
School houses	13	1 547 000
Churches	6	446 000
Public buildings (municipal)	35	2 304 000
Public buildings (amusements, etc.)	78	6 347 000
Stables and garages	42	1 373 135
Other structures	121	168 810
Total	749	$115 654 455

In the matter of alterations to buildings, plans were filed during the year for alterations to 3 637 buildings, at an aggregate estimated cost of $11 031 728.

BOROUGH OF BROOKLYN.

In this Borough 5 172 new buildings were completed in 1912, costing $30 088 484.

The alterations completed during the year affected 3 987 buildings, costing $6 195 843.

Plans for 5 105 new buildings were filed and acted upon during the year.

Work is in progress on the Central Library Building, which is being erected at the intersection of Flatbush Avenue and Eastern Parkway, at a total estimated cost of $4 610 208.

Work on the Eighth Ward Market is practically at a standstill, owing to lack of appropriations. This property represents an expenditure to date of something over $1 000 000, from which no benefits, either financial or otherwise, are being received.

Plans and specifications have been prepared for two comfort stations, one to be located at Williamsburg Bridge Plaza and one at Knickerbocker Avenue and Bleecker Street. The contract for the comfort station at the Williamsburg Bridge Plaza is about to be awarded, at a cost of $21 000.

Owing to objection on the part of the property owners, the station at Knickerbocker Avenue has been abandoned. Work on the building on the southeast corner of Willoughby and Raymond Streets, in order to fit up the same for a civil prison, is in progress, at a cost of $14 889.

Borough of the Bronx.

Plans and specifications for new buildings filed in the Bureau of Buildings during the year 1912 are as follows:

Classification.	No. of buildings.	Estimated cost.
Brick dwellings	157	$975 750
Brick tenements	606	25 184 500
Frame tenements	1	8 000
Hotels	1	10 000
Stores	66	784 950
Office buildings	17	740 875
Manufactories and workshops	65	1 857 000
School houses	7	919 000
Churches	8	58 000
Public buildings (municipal)	9	1 445 500
Public buildings (places of amusement)	58	2 086 600
Stables and garages	91	839 000
Frame dwellings	187	779 200
Other structures	47	10 980
Totals	1 310	$34 644 400

Plans have been filed for alterations to 2 529 buildings at an aggregate cost, estimated, of $1 405 470.

The building operations in the Borough of the Bronx for the year 1912 shows an increase of nearly 48% over 1911.

Over $25 000 000 was the estimated cost of tenement houses alone planned in 1912, which exceeds by over $11 000 000 the corresponding cost in 1911.

The cost of dwellings in 1912 decreased $1 200 000 as compared with the previous year.

The cost of public buildings (municipal and places of amusement) in 1912, amounted to over $3 500 000, or about $1 500 000 in excess of 1911.

The increase in the cost of factory buildings in 1912 exceeded the cost in 1911 by about $800 000.

Substantial increase is also shown in the cost of school-houses from $129 000 in 1911 to $919 000 in 1912.

Borough of Queens.

Plans and specifications for new buildings filed in the Bureau of Buildings during the year 1912 are as follows:

Classification.	No. of buildings.	Estimated cost.
Frame buildings	2 497	$7 309 700
Frame store and dwelling	68	178 525
Frame tenements	1	4 000
Frame store and tenement	1	4 500
Other frame structures	436	134 650
Brick buildings	640	2 705 800
Brick stores and dwellings	164	796 400
Brick tenements	196	1 865 800
Brick store and tenements	17	167 500
Public buildings (municipal)	12	605 500
" " (places of amusement)	52	523 100
Manufactories and workshops	76	1 817 250
Churches	6	98 500
Schools	4	419 000
Hotels and boarding houses	18	246 600
Hospitals	1	87 000
Storage warehouses	22	95 850
Office buildings	23	240 875
Stables and garages	292	234 338
	4 520	$17 529 938

In this Borough plans and applications were filed during the year for alterations to 1 363 buildings at an estimated cost of $914 878.

The Town Hall at Flushing, a building 50 years old, has been thoroughly renovated, repaired and painted both interior and ex-

terior, by Department labor; the entire building has been re-wired for electricity and new fixtures installed.

Alterations, repairs and renovations have also been made to the Town Hall at Jamaica; Town Hall, Newtown; Magistrates' Court Building, Far Rockaway, and in Long Island City, to the Queens County Court House, Borough Hall, interior of floating baths, and Municipal and Magistrates' Court Building.

Borough of Richmond.

The building activities in this Borough are represented by the erection of 1 007 new buildings at a cost of $3 153 256. The alterations made during the year have affected 512 buildings, and have cost $406 143.

STREET CLEANING.

Thirty-one thousand dollars have been appropriated for additional dumping stations; one at West One Hundred and Thirty-fourth Street, North River; two on the Harlem River, Borough of Bronx; one at Clinton Street, East River; and one at Lincoln Avenue, Harlem River, Borough of Bronx. The latter stations will be covered dumps.

New auto-trucks, flushing machines, sweeping machines, snow melting devices, etc., have been experimented with throughout the year.

In the Boroughs of Manhattan and Bronx, a contract has been prepared for the entire disposal of refuse. In the Borough of Brooklyn, in addition to the contract for the disposal of refuse as in the other boroughs, the contractor furnishes the dumping stations as well. This form of contract relieves the Department of the duty of construction and maintenance of dumping stations.

All contracts for final disposition of refuse expire on December 31, 1913, and specifications for improved method of disposal are now being prepared.

In the Borough of Queens, the population served by the Bureau of Street Cleaning in the matter of refuse collection was 340 000 which is 30 000 more than served in 1911.

The material collected is estimated as follows:

Ashes	172 000	cu. yd.
Garbage	222 000	" "
Rubbish	63 000	" "
	457 000	" "

The ashes are disposed of at inland dumps, and also for bringing public highways up to grade, filling in street depressions and depressions in sidewalks.

Of the garbage and refuse, 55% is dumped in open lots, 32% is cremated, 8% is subjected to a reduction process and 5% is taken to piggeries.

During the year plans and specifications have been prepared for the construction of a refuse destructor capable of disposing of 100 tons of refuse daily. A thorough study has also been made of conditions in the Borough of Queens with a view to arriving at a sanitary disposition of garbage and rubbish.

In the Borough of Richmond a second refuse destructor of improved type has been completed, fully equipped with labor saving devices, and built upon the basis of a combined first cost and guarantee operation capitalized.

CITY PLAN.

Borough of Manhattan.

A complete survey of the Borough of Manhattan is under way, the object of which is to establish and map building lines, curb lines and street grades.

Sixty thousand feet of building lines and sidewalk encumbrances have been located; 375 vaults have been measured and 435 bench marks have been established.

Plans affecting 13 streets have been prepared for widening and removal of encroachments.

A sub-surface division was organized in 1912. Its functions are the accumulation of information concerning water, gas and steam mains, subways, sewers, electric conduits, vaults, etc., all of which information is accurately plotted on record maps, making it possible to reduce pavement mutilations, and assign definite locations for future sub-surface construction, thus avoiding disturbances to

existing sub-structures, and furnishing reliable information regarding sub-structures to Departments and Corporations.

In connection with this work 45 000 ft. of surface topography have been surveyed; 500 manholes have been detailed and plotted and 2 500 street openings have been examined.

The New York Central R. R., has submitted plans and specifications for the viaduct on Park Avenue, connecting the upper level of their station with Park Avenue at Fortieth Street, which plans are now under consideration.

A reinforced concrete stairway street is now in the course of construction at West Two Hundred and Fifteenth Street from Broadway to Park Terrace East.

A two-level street for West One Hundred and Fifty-fifth Street from Broadway to Riverside Drive has been designed so as to harmonize with the Riverside Drive Extension.

A service street has been designed adjoining Riverside Drive between One Hundred and Thirty-ninth and One Hundred and Forty-second Street.

Borough of the Bronx.

During the year, the Board of Estimate and Apportionment has approved 81 maps of streets and amended streets which have been filed in the office of the President of the Borough of the Bronx.

Ten thousand five hundred permits for opening streets, crossing sidewalks, erection of buildings, alterations and removal of same, have been examined with reference to interference with monuments and street lines.

An appropriation of $230 000 has been made for the construction of a transverse road for heavy traffic under 161st Street from Walton Avenue to Sheridan Avenue, with approaches to the Concourse from Sheridan Avenue from Central Bridge, the latter being an elevated structure, for which contract plans are now in progress.

Two hundred and twenty-five thousand dollars have been appropriated for the improvement of Fordham Square by covering the depressed tracks of the New York and Harlem R. R. from Welch Street to the north side of Fordham Road. The proposed construction will convert into an open plaza the entire area bounded

by Park Avenue West, Fordham Road, Third Avenue and Welch Street. Plans and specifications have been prepared for this work.

Borough of Queens.

A system of numerical street naming has been prepared, and a division for interpreting the adopted grades to determine house line and curb line elevations has been established.

Since consolidation, 45 877 acres have been tentatively mapped, the maps adopted amounting to 61% of the Borough.

Four thousand eight hundred and forty-seven monuments have been set, and maps for 240 street opening proceedings have been prepared.

CONCLUSION.

When consideration is given to the many duties of a departmental nature which the President of the Municipal Engineers of the City of New York is required to review in his annual address, it is perfectly manifest that no such compilation would be possible within any ordinary period of time without the hearty co-operation of the heads of Departments and engineers in charge of work throughout the municipality, and to all of these gentlemen who have so cheerfully and promptly furnished me the necessary information in the preparation of this report, I desire to express my grateful appreciation.

ANNUAL DINNER.

The Tenth Annual Dinner of the Society was held at the Hotel Savoy on Saturday, January 11, 1913. Four hundred and fourteen members and guests were present. The President of the Society acted as toastmaster. The addresses delivered were, in part, as follows:

SIDNEY W. HOAG, JR., M. M. E. N. Y.—Gentlemen, members and guests: In extending the cordial invitation of this Society to our friends and guests here this evening, it may be proper to announce that this assemblage of technical men is celebrating the tenth anniversary of the organization which they represent—The Municipal Engineers in the service of the City of New York; and the appearance here of so many familiar faces, after ten years of changing conditions, changing administrations and civic difficulties of every kind, all tending towards confusion, and all of these people drawn together by the cohesive power of one set purpose each one resolved to do his share towards working out the destiny of our home town, is a worthy tribute to a worthy commentary on the Civil Service Law.

The principal difficulties that beset this city in its onward march of progress are two-fold. One is the intensely magnified and aggravating conditions affecting traffic and transportation, and another is the cosmopolitan character of its people. Both of these conditions tend toward selfishness of purpose, inspired on the one hand by raw necessity and by a mistaken idea of personal liberty. The two giants that have thus far been able to successfully cope with this situation —wise legislation and education. Our ordinances and statutes curb and control within proper limitations that independence of individual action and behavior, which is but the natural result of personal liberty.

Our educational institutions, from the alphabetical class and the kindergarten to the university, broaden the mind and inspire it not only with a high sense of civic responsibility in the category of citizenship, but also with an individual understanding and appreciation of what is commonly called community interest, and the best result obtainable from the efforts of these two forces, is an Americanized people, inspired with civic pride and patriotism.

The educated man must dominate the situation, be he merchant, doctor or lawyer, Engineer or architect. Educated cosmopolitanism must be the saving grace of this municipality, with a logical, inevitable, and I may add, inexorable process of amalgamation and assimilation, such as has been so well depicted on the stage by Walker Whiteside in the "Melting Pot". And the educated type of this product tends towards cohesion, unity of purpose and the harmonious pursuit of ideals. The members of this Society represent the technical activities of the City of New York covering a very wide and variegated field of specialties. And the necessity for this situation can be appreciated after one has undertaken to form some conception of the bigness of this town. A glance at the annual report of the Finance Department on the City payroll, staggers one in his endeavor to grasp its significance. No one individual can hope to form any mental conception of the bigness of this city, with its multifarious business details. It is no wonder that an almost universal demand for standardization along every line should have arisen.

I have heard the attempt to standardize denounced as an attempt to pave the way for the abolishment of the engineer. And almost a quarter of a century ago, when the American Society of Civil Engineers inaugurated the idea of appointing special committees for standardizing of this and that, there were those who opposed the proposition because as they claimed, it tended to curtail the opportunities and usefulness of the Consulting Engineer. Standardization should be no bug-a-boo; standardization means greater efficiency, greater uniformity in methods of operation, greater speed, and therefore economy in time, and as time is the essence of every transaction, standardization stands for the very highest form of economy especially in the preliminary stages of any enterprise; but applied ignorantly it is sure to lead to embarrassment, and result in more work for the engineer, by precisely the same process whereby the incompetent and ignorant surveyor makes more work for the good surveyor and technical experts. But all the standardizing in the world can never result in dispensing with the technical man or in relegating his services to the past. When the technical man stops, safe, sane and rational progress will have to stop, and this sentiment ought to suggest just about how much the world to-day is beholden and obligated to the

technically trained man. The world may dream its dreams; it may paint its most astounding fancies in glowing colors, or it may describe them in pages of illuminated manuscript, but the fulfillment, the actual creation of the physical entity, the reduction of ideas to a measurable material fact, must forever be the work of the technical man.

It was perfectly natural that in the metropolis of the Nation, the men who actually do things for the City should be the pioneers in getting together and organizing, with the object in view, quoting from our constitution, "to further the material development of the City of New York, to elevate the standard of efficiency, harmonize the work of the enginering staffs of the several departments of the public service, and to promote the technical, professional and social interests of the engineers in the employ of the City". This organization has set the pace for other municipalities. Only this last fall the Municipal Engineers of the City of Philadelphia organized on lines similar to our own, with a constitution modeled on the constitution of the Municipal Engineers of the City of New York. As long as we live up to our ideals in purpose, we have every reason to to hope to and we deserve to thrive and prosper as an organization. We have no motto, but I would like to suggest as a motto for this society, *fides civica,* "Civic trust and fidelity". In that expression we have motive, determination and accomplishment all combined, and in an idiomatic sense, civic pride. Why should we not be stirred and controlled by civic pride? Where does the sun shine on any other such cosmopolitan municipality, governed any better than or even as well as the City of New York? Every man of you should be thrilled with jealous pride of your citizenship and with a still deeper pride from the consciousness that each and every one of you is a component part of that great machinery that in its daily operation is pushing and urging the City of New York on and on to its ultimate destiny as the imperial city of the world, a city of great possibilities and great achievements, an example in self-government for all other municipalities, a city without a peer. All hail the City of New York and long live its Municipal Engineers!

In a retrospection of about a quarter of a century, I can see a gentleman in the Municipal service working as one of our colleagues in the ranks, starting, so to speak, from scratch.

With a most peculiar personality and an ability to express himself in the most vigorous and forceful Anglo-Saxon, it was no wonder, ten years later, at the time of consolidation, that he outstripped all handicaps, and became Chief Engineer. Again, it created no surprise when, eight years later, as the head of a department, his old colleagues were obliged to address him as Commissioner; and now, for the second time, we find him installed at the head of the engineering activities of the Empire State. This gentleman, during his municipal service, had abundant opportunity to become fully informed on water, both fresh and salt, and there is no doubt but that he can give a good many of the gentlemen here present valuable tips on the difficulty of obtaining clear fresh water and what to do in the meantime. He will respond to the water and what to do in the meantime. I take great pleasure, gentlemen in presenting to you, as a graduate of the Municipal Service the gentleman who will respond to the toast, "The State and the Municipal Waterways", our fellow member, the Hon. J. A. Bensel.

HON. JOHN A. BENSEL.—Waterways, in my mind, mean only either state or national waterways, because in that term we recognize that which makes them public highways; it means that transportation which the people have taken over to themselves as being something which they insist upon the nation or the state furnishing. To-day we find not only in this state, but in the neighboring country and Canada and in the countries abroad, it is the growing sentiment that it is the duty of the nation or the state to furnish that means of transportation which shall forever free the people from any form of compulsory tribute to corporations for something which is not within their control. That, to my mind, represents the popular feeling that people have to-day for the waterways. I found, in a recent trip to Canada, that in that country they are contemplating, within a few years, an expenditure of three hundred million dollars in fixing up their waterway proposition. They pay no attention to any other form of transportation, so far as the public is concerned. That country has no money to spend on army, navy or pensions, and takes the receipts from its customs and puts it altogether in public improvement. That form of public improvement which appeals to the people to-day is the extension of

their waterway system. What shall we say in this country, where we have expended, so far as the national government is concerned, something over one-half a billion dollars, and have yet received no commensurate results? What the reason of this is, no one can lay down, but probably it has to do with the fact that, although the people of the country have recognized the public ownership in the waterways themselves, they have forgotten to take control, until very recently, of the terminals which feed these systems and which this Empire State of ours is the first state to recognize in its importance.

I take it that, so far as the Municipal Engineers are concerned, so far as all engineers are concerned, this particular era, where the people are commencing to look for their own, is one that we can look upon with some gratification, for, after all, the proposition to which we are brought is one to perform services, and I take it that no one in our profession is as happy as when he is called upon by the public to perform some public service. So that, in looking over the field to-day, there may be some gratification in all of our hearts and minds that we are citizens of a state which stands at the forefront of those states which are looking for improvement in the transportation facilities; and not only that, but the public control of that portion of it which will render its citizens free from any possibility of being held up or bound by any form of private control.

So far as the New York State system is concerned, it compares in its new layout approximately as the railroad of to-day compares with the railroad built at the time of the Civil War. And I think that possibly the fairest conception may be had of what this new form of transportation means if you will try to realize that it will be possible for a boat three hundred feet long and forty-five feet in width to go from the easterly to the westerly end of this state, and from the northerly to the southerly limits also, within a period of two years from the present time. To my mind, it means an awakening in this state, probably as great as the state had when the Erie Canal was first opened.

So far, however, as we are concerned as engineers, we could take only that portion of this problem to ourselves with gratification, that we are living in an age which may be called progressive, and

it means a movement for public service, and one we can congratulate ourselves upon, that we have come into our own. The greatest poet of modern times has expressed that in saying of New York:

"Wary and watchful all our days,
That our brethrens' days may be long in the land."

SIDNEY W. HOAG, JR., M. M. E. N. Y.—The next speaker, gentlemen, is one of our most public-spirited citizens and indefatigable municipal officials, whose field of interest, activity and endeavor is not limited by any dogmatic consideration of official sphere of duty. His active interest has never been confined to any one single line of public welfare or public interest. I often wonder how he gets that quantity of sleep which Nature demands, and how he works that brain as he must, without wearing out. But men of this type may be relied upon to keep the world moving in the direction of progress, which means ultimately what we all delight in, plenty of serviceable, profitable and commendable work. I do not think I err when I state that this gentleman views the future of old Father Knickerbocker from the standpoint of an optimist, and I believe that he considers the privilege of laboring for the prosperity and greatness of New York a privilege, and I take great pleasure in presenting to you our fellow member, the gentleman who will respond to the toast, "The Glory of Father Knickerbocker", the Hon. Calvin Tomkins.

CALVIN TOMKINS, M. M. E. N. Y.—Gentlemen, as a member of this Society and Dock Commissioner, I think it right to say that if Mr. Hoag's salary was not already larger than mine I should probably recommend that he be raised $1 000.

Now, then, as to this toast, "The Glory of Father Knickerbocker." Looking at it from the Dock Department standpoint, I infer that reference as applying to the glory of this "peerless" city. Now, whenever I have the opportunity of addressing the Municipal Engineers, I consider it a special privilege, because the glory of the City of New York does not consist in its magnificent harbor, or in being the terminus of the great national highway across the State of New York which Mr. Bensel has charge of—we are not responsible for that—it is not dependent upon the great congregation of population focused here as a consequence of its unusual opportunities. If anything, it is not due to the cosmopolitan spirit of the

city. New York is the most cosmopolitan, the most careless, the most liberal city in North America—probably in the world—in everything except its own material welfare. The saving glory of the City of New York is that bit of civic pride, the old Greek sentiment injected into the Twentieth Century, that our President has referred to, namely, the educational advantage and critical opinion on the part of the people who know what they are doing and what they are talking about. Other cities are careful of their public works and growth and material welfare in contrast to ours, and it is to this body, more, perhaps, than any other body in New York City, that we have to look for that educational guidance which will really make New York the peer of other American cities.

I always feel, in addressing the Municipal Engineers, that I am really closer to the intrinsic government of the City of New York than when I appear before the Board of Estimate and Apportionment.

Now, then, I am an optimist. New York is the biggest city in North America, and is the greatest port in the world. That is nothing to be especialy proud of. It is not quantity, but quality; it is not population, and area, and big buildings, and commerce, and industry: it is civilization and organization that are the essential things that make a city great and worth living in. As a city increases in size, the problem of governing it and adjusting one's living conditions to its environment is an increasing difficulty, and complicated one, and the time for dependence upon any organization of old-fashioned political union is long gone by. Those cities which depend upon expert guidance and control are the ones which will forge ahead, and, at the present time, New York is not in the lead in that respect. Boston, and Baltimore, and New Orleans, and San Francisco, and even Philadelphia, judged, at least, from the aspect of port improvement, are ahead of us. I think in subway development and in other municipal activities we are ahead. Judging from that standpoint with which I am most familiar, I know the City of New York is the most backward port, not only in America, but in the world.

Great cities have only been possible in comparatively recent times, due to the railroads, steamships, telegraphs, the processes of feeding, for bringing in the raw materials and sending out the

finished products, and the terminal organization on which cities depend primarily. The terminal organization is beginning to break down in the City of New York. From now on we will notice an increasing manifestation of our lack of progress, as compared with our rivals. We have depended too much on our natural facilities and not sufficiently upon our enterprise, as do the smaller cities who are struggling in competition with us. There are at the present time thirty or forty applications from railroads and steamships seeking accommodations at the water front of the City of New York which cannot be provided, and their insistence has assumed such proportions that the criticism is becoming very acute, and I pass the responsibility over to the Board of Estimate. I must put it up to the people who are really responsible back of me. It is a situation which will become more and more uncomfortable, and there is no possibility of catching up with the situation within a great many years. We have allowed it to go too long to immediately rectify it. The Hamburg-American Steamship Co. will have two of its large steamers running to Boston this year; next year the *Amerika* will be put on, making weekly trips to Boston, with far better railroad service there than we have in New York. Lines have left us for Baltimore, Providence and Philadelphia, and there are now lines which are considering leaving New York for other ports if they cannot be provided for here, and I see no present possibility for providing for them. We must necessarily lose some, and every time a line is established in another port, it means a great deal more than the loss of these two ships—it means the establishment of a nucleus of commerce. And our factory connections with the terminals are worse here. New York is the most expensive city to pass commodities through, to take them to the factories from the steamships and railroads. There is no adequate system of articulation between the railroad and pier. Boston has recently established that; Baltimore has established that in part; Philadelphia, through the municipal marginal road, has attempted to do so; Montreal has done so; so has New Orleans; and we are behind all those cities. And as compared to European cities, we are far behind. The German, the Belgium and Holland ports have been organized, and the shipping facilities have been co-ordinated with the docks properly, and they have not done that elsewhere.

The port in its relation to the market of the city is most important, and when I refer to the market I do not have reference entirely to the food market, which President Miller has so effectively taken under his supervision, but the markets of the city, including the markets for raw materials, markets for coal, and the markets for export of the finished products. The articulation of the railroad and steamship system of the port with the industrial factories of the port is very bad, and we are now the first great manufacturing city in North America. One-eighth of the entire manufactured values of the country are manufactured right here, within twenty miles of City Hall, in New York and New Jersey, and if we are to retain that pre-eminence, we must organize our distributing system for raw materials, fuel and finished products, as well as for the food.

The great problem of New York, in my judgment, and the Honorable State Engineer has referred to it, is not a problem of water front, pier and dock construction but of articulation of railroad terminals by marginal roads which shall provide an unobstructed passage for lines parallel to and behind the docks as provided by the harbor water in front of the docks. That is what we must look forward to and ultimately it will be worked out. Mr. J. J. Hill, since Mr. Harriman's death probably the greatest magnate in the country, has called attention to the same fact that the breakdown in the railroad system of the country is due to the inefficient municipal terminals. The great expense connected with their extension is on account of acquisition of lands and the great difficulty of changing the city plan in order to readjust the railroad system, and this is more difficult in New York because the right of ways of the railroads are more intense; because we have the port located in two states, because we have let the problem go so long, and, finally, on account of the bigness of the city itself, and I may add on account of its separation into four great parts by the harbor waters. At South Brooklyn the problem is a comparatively simple one, and the Board of Estimate and the Dock Department have come together in the solution. On the west side of Manhattan, I think we are gradually approaching the same solution in a marginal road; whether surface or elevated or subway, depends upon the comparative merits of either one of these. In the judgment of the

Dock Department, the elevated road is the most practical. There has been no strong argument against the marginal railroad. It modernizes the terminals of the one great system of railroads from the north of this State, the New York Central and its practicability is demonstrated by the fact that that road is willing to build it at its own expense, but the other roads will be forced to develop their terminal facilities. The position of the Dock Department is this, that when we shall have modernized the New York Central terminals, the other roads, per force, must meet the new conditions which have been provided and modernize their terminals, and it is not an easy thing, and I find myself frequently mingling my tears with those of Lackawanna, Erie and Pennsylvania officials and find no satisfactory solution.

In the other boroughs the problem is similar. In Staten Island it will be the terminals of the Baltimore and Ohio; in The Bronx, the terminals of the New Haven System.

The New York problem is a national one and not a local one; that is too generally disregarded. As the State Engineer has stated, we are the terminus of the great national highway across the state * * * the Erie Canal from the Great Lakes to the East, terminates at New York * * *. The State seems to have lost sight of its greatest asset. The Mayor of the City of New York, the Governor, the State Engineer and the principal officials of the State and many of those of the city, are beginning to recognize this situation, that we have the finest harbor in North America, and the only level road across country leads to it, and we are at last beginning now to solve the problem of utilizing its advantages.

We had the laws amended, through the Corporation Counsel, necessary to meet the situation. We have the money in the forty year's earnings of the Dock Department available for docks and subways; we hope they will leave some of it to us for docks. We also have an increased public opinion. The Chamber of Commerce, Merchant's Association, the City Club and every prominent organization in the city have ratified the plans of the Dock Department, and now we are awaiting the action of the Terminal Committee of the Board of Estimate. Our plans have been before them for months, and in some instances for years. The term of office is nearly over, we have only one year left of the four; the

municipal elections are within a year, and I hope we will secure some action before the municipal elections are upon us.

One final thought to go back to the sentiment expressed by our President. The great asset of the city is the broad community spirit of the City of New York, the public spirit in the largest sense of the city. The old Greeks, in the days of Athens, did not understand that there was any difference between public interest and private interest. Man's ordinary business was as much the public business as it was his own. Public housekeeping and private housekeeping were interchangeable terms, and we must look to that growing sense of community interest to make New York City the city that we wish to make it.

A short time ago I put a book by my bedside to go to sleep by, entitled "The Greek Commonwealth," by Zimmerman. I found it most interesting, and turning to a page I read:

"In all the work they did for us and tried to do, these cheerful Greeks were sending a tiny human strength of their own will against the heavy dead weight of material forces, which they could neither control nor understand."

Now the difference is, that the dead weight of these many forces are now understood and they were not and could not be understood at that time, and can be harmonized to the advantage of civilization instead of presenting a dead wall against which the brightest minds battered themselves, and it is the responsibility of this body of men to carry the torch on and arouse that public spirit in the City of New York—the old Greek idea.

I have found that the reason that I have neglected my private business for the public business is because the public business is far more interesting than my private business.

MR. SIDNEY W. HOAG, JR.—Some of our members can probably go back to the days when, as students of the New York University, they received their degree from that venerable Chancellor Crosby, when, as he used to state in installing these degrees, "Hic diploma, sic testimonio." But most of our New York University representatives obtained their college training under Chancellor MacCracken. In 1911 his succesor was taken from the Federal Department of Education at Washington, when New York went to the Nation's Capital and practically kidnapped the Commissioner of Education.

On account of the personality of this gentleman and the wide impression he had created amongst the educators of the world, his installation as chancellor of the New York University was attended by probably one of the greatest assemblages of the world's educators ever gathered together at any one time in New York City.

His one aim and ambition is to become associated with the public life of New York City where he is already a factor. I will ask him to respond to the toast, "Universities and Public Service," and it gives me great pleasure, gentlemen, personally to have the honor of presenting to you, Chancellor Elmer E. Brown of the New York University.

DR. ELMER E. BROWN.—Some time ago I heard one of our most eminent college presidents speaking of the general subject of college education and he took pains to say, "I am speaking of college education in which our main purpose is public service, I am not speaking of professional education in which the main purpose is private advantage." Now that, I think, is the attitude of those who complain that our college education is going to the dogs. Because our young men are turning so largely into the engineering courses, they believe that they are turning from the purpose of public service to the purpose of private gain. Now that is exactly the view that I want to protest against to-night. I am well aware that there are professional schools and there are professional students who are seeking chiefly their private advantage. There are people in every walk of life who are thinking chiefly of their private advantage. But the professional education of the present day, including the engineering education, has for its main purpose that everlasting purpose of all good education—the service of the public good.

I am not afraid of the professional tendency in our modern education, so long as our professional education is increasingly scientific. Have you ever thought how those two things, the pursuit of science and the pursuit of the public good hold together? As we make our professional education more scientific, it emphasizes more the service of the public and so in our university work at the present time I think we can look with equanimity upon the tendency of the young men to seek what are called the practical courses, because the practical courses are the scientific courses and

scientific courses emphasize with the strongest intellectual emphasis the idea that a man lives for mankind. I suppose that there is no other branch of our university life in recent times that has made so profound an impression upon the whole American people, as has the new development of instruction of our state universities; the University of Wisconsin is spoken of as the most striking example. What is it that has made the state university so peculiarly effective and influential. I think it is this. I think that they permanently have recognized this fact, that every human occupation, particularly that of the common laborer or worker in the kitchen, the worker in manual occupation, up to the work of the highest of the professions, that the work of all of these occupations is a scientific study. The work in the kitchen, yes, has a scientific side in economics; it has a scientific side in sociology. I sometimes think that my own kitchen is a social center. But the thing of it is that every occupation in life has its scientific side, and as we emphasize that scientific side, we are emphasizing devotion to the common good; and so I believe that the work of universities is going in this way to emphasize more and more the idea. Our boys are to be sent out not simply with emotional appeals to them to serve the public, but with the idea grounded in them by the very course of their scientific training, that it is the business of life. One of the best texts that I have to give to my college boys is to be found in the last words of the speaker who preceded me, that he had continued in public practice to the neglect of his private practice, because he found the public service more interesting.

I am told, too, that probably over half of the men here present would to-day be making more money in private practice, or would have made more if they had continued in private practice through these long years past. That is a magnificent illustration of the point I should like to make.

Mr. Sidney W. Hoag, Jr.—The next speaker, gentlemen, represents a trifle younger generation than some of the older members of this Society. He is a complete product and expression of New York and its Institutions. After graduation from the College of the City of New York, he entered the study of law and was later selected by Mayor Gaynor as a member of the old Aqueduct Commission, and through his peculiar energy, the affairs of that com-

mission were rapidly closed up, followed by the resignation of the Commission because of nothing else to do.

On the resignation of Raymond B. Fosdick, he was appointed by the Mayor Commissioner of Accounts, the position which he now holds in conjunction with Commissioner Rice.

It may be said that his present position as Commissioner of Accounts requires him to perform his duty with the aid, figuratively speaking, of the X-ray machine. If my memory is correct, when the Roentgen rays first appeared in the public eye, the Crook's tube was somehow associated with it. And while this is a very suggesting adjunct to the plant of the Commissioner of Accounts, let us hope that his best endeavors may succeed in vindicating all of us from any such aspersion. I have asked him to respond to the toast "The Municipal X-Ray," for I do not think there is any official in the municipal service any better equipped with such auxiliary apparatus to perform these duties. And regarding him as I do, a brother alumnus, I will ask you to join me in drinking to the health of the Hon. Jeremiah T. Mahoney.

HON. JEREMIAH T. MAHONEY.—Your worthy President, in his introductory remarks, called attention to the fact that I have held one or two positions under the city administration that might possibly qualify me in talking of the problems of the engineers today, but he left out one or two jobs. I feel I hold one of the most interesting records with this administration, almost unsurpassed. Do you know, I have held four separate jobs in this administration and it is only three-fourths over? I was counsel to the Comptroller, and I resigned. My dear friend, the Mayor, appointed me an aqueduct commissioner, and well do I recall the amazement of the State Committee on Cities, when I spoke in behalf of the Bill I introduced to abolish my position and drive me from office. They said that was the first time in the history of the Legislature of the State of New York that a man appeared in advocacy of a bill that would drive him from a municipal position. I likewise served on the Board of Education, and that position I resigned. I am now Commissioner of Accounts and some day I will be kicked out.

I have studied the history of the position of Commissioner of Accounts from the time of its creation to the present day and I

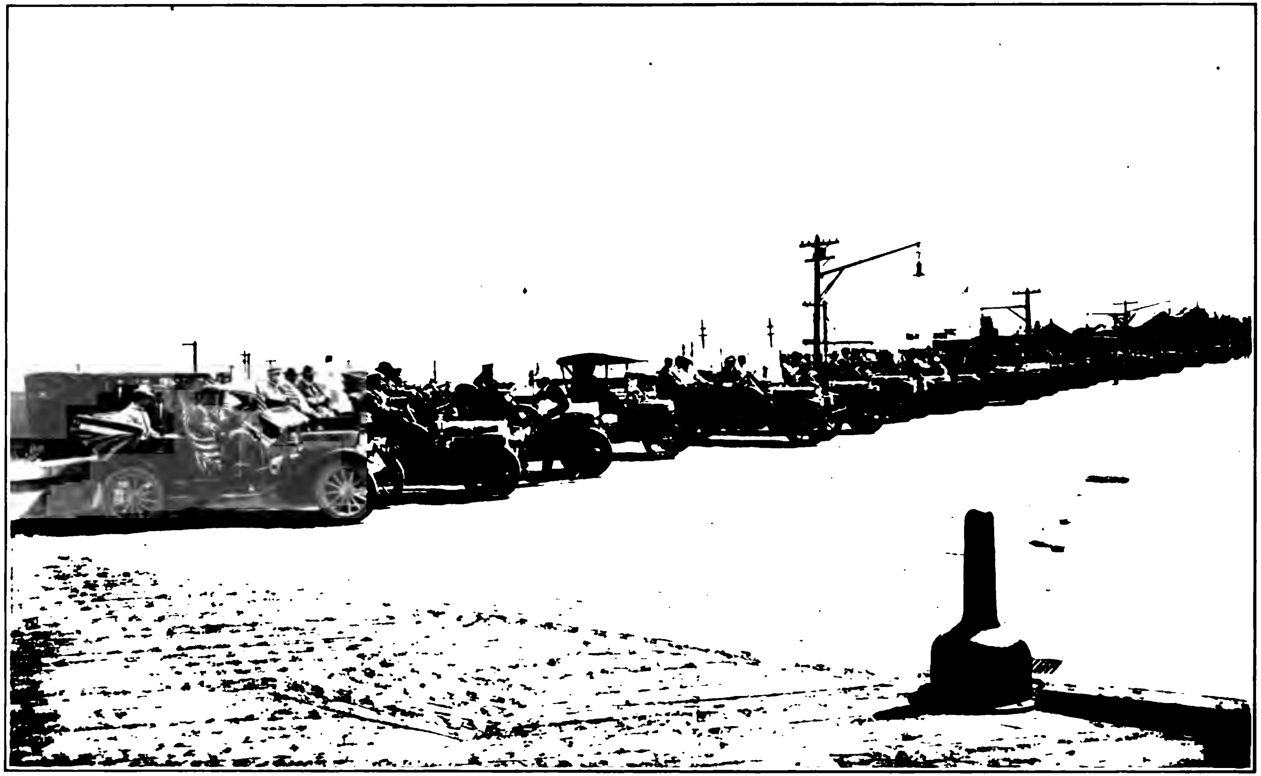
know how we are supposed to be, as your chairman says, the eye of the Mayor; how we are supposed to ferret our irregularities, how we are supposed to make the administration more efficient; but, in my opinion, one of the most solemn duties we have to perform in that position is not so much the ferreting out of crime, not so much to see to it that those who do something wrong shall be punished, but above all to see to it that those officials who are honest and efficient and who are abused, are protected in their good name.

The City of New York to-day has solved some of the most difficult problems that have confronted her, and she has successfully solved them by her own employees, in a great measure, and that is what I hope she will do in the future; that those men who constitute the Board of Estimate and Apportionment will realize fully that the most scientific and most efficient teachers of efficiency are to be found on her own payrolls, and that there is no great necessity of introducing into our departments at present these alleged trained experts belonging to other societies.

I know only three or four years ago, the City of New York was about to propose some great and mighty public improvement. There was the old cry of the debt limit, and you all remember well the many mighty improvements that were held up pending the solution of that question. The City of New York took up the problem itself to increase its borrowing capacity, and under the decision of the Court of Appeals, which I was pleased to have been permitted to argue, rules were laid down that the City of New York at any time could tell what her constitutional borrowing capacity is. Just think, during the present administration the city has seen fit to have the law amended so that we are now able to have a semi-annual collection of taxes, instead of running the government from the first of the year on borrowed money, at four, five and even six per cent. The semi-annual collection of taxes results in a saving of a million and a half dollars a year. Just think of that wonderful advance due to the amendment of the charter permitting short-time corporate stock notes. All you engineers know, only a year or so ago, if any improvement was initiated you would have to wait not only until the Board of Estimate authorized the expenditure, but you also had to wait until there was a favorable market for the

sale of corporate stock. That is now not necessary. Any improvement can be begun almost the moment it is initiated.

And again, take the creation of the segregated standardized budget. I know with many of you probably this instrument does not find much sympathy, but I know that within a very short time its advantages will be fully realized and we will then wonder what the City of New York was without a segregated budget.



Automobile Inspection through the Borough of Richmond on May 28, 1912.

AUTOMOBILE INSPECTION THROUGH THE BOROUGH OF RICHMOND, MAY 23, 1912.

On the excursion through Staten Island, the first point of interest was the refuse destructor at West New Brighton, where all house refuse, garbage, ashes and rubbish are incinerated by means of a forced draught of preheated air. The gases evolved are burned to generate heat for boilers and the resulting gases passed off through a high stack, the clinkers being used for filling or for concreting. The destructor has a capacity of 60 tons per diem, and, although located in a residential district, has given rise to no complaints on account of nuisances.

The next stop was made at Concord to inspect a trunk sewer under construction in which a steam shovel was being used for excavating the trench.

Another point of interest was the Sea View Hospital, in course of construction, covering fifteen acres of ground and containing eight wards and seven general buildings, with a capacity of one thousand beds. A number of the wards are of reinforced concrete construction and the remainder of steel.

After inspecting the Ocean Terrace Drive, the party assembled at "Philosophers' Retreat," Emerson Hill, where refreshments were provided by the Staten Island Board of Trade. An informal meeting was here called to order by the President of the Society, in a clear space among the trees, and addresses were made by George Cromwell, President of the Borough of Richmond; Louis L. Tribus, Consulting Engineer, and acting Commissioner of Public Works; William S. Van Clief, President of the Staten Island Board of Trade, and Cornelius G. Kolff, owner of "Philosophers' Retreat."

The party then visited Silver Lake Reservoir site upon which the Board of Water Supply is to construct the terminal reservoir of the Catskill Water System to be supplied from the Ashokan Reservoir in the Catskill Mountains.

HILL VIEW RESERVOIR.

INSPECTED BY THE SOCIETY OCTOBER 19, 1912.

At the inspection of Hill View Reservoir, being constructed by the Board of Water Supply as a regulating reservoir to equalize the flow of water to the City from the Ashokan Reservoir, the party examined the block paving of the slopes, the concrete lining of the reservoir bottom, the dividing wall, the uptake chamber, where the flow of water is to be controlled by sluice-gates and may be turned into either or both basins of the reservoir or by-passed through the dividing wall to the City, and the downtake chamber which will regulate the flow from the by-pass aqueduct or from the basins to enter the City tunnel or to be blown off to the Bronx River through a combined blow-off conduit and sewer.

MEETING AT "PHILOSOPHERS' RETREAT" MAY 28, 1912.

MEMOIRS OF DECEASED MEMBERS.

CHARLES BURTON WINTERSTEIN.*

Charles Burton Winterstein died at his home in Brooklyn, March 10th, 1912.

He was born in Hamilton, Ohio, October 6th, 1872, and was educated in the public schools of that city, from which he graduated, and later attended Cornell University for about two years.

From 1890 to 1898 he was employed as follows: Chainman and Instrumentman with Ammerman & Ford, New York City; Assistant to the County Engineer of Butler County, Ohio; Instrumentman and finally in charge of reconnaissance and final surveys of an electric railway from Cincinnati to Dayton, Ohio; in charge of construction of the Belt Railroad, Hamilton, Ohio; 1898 to 1900, Draughtsman, Niles Tool Works, Hamilton, Ohio; 1900 to 1903, Machine Shop of the De La Vergne Machine Co., New York City; appointed as Rodman in the Department of Docks and Ferries, October, 1903, Leveler, August, 1904, Transitman, April, 1905, Assistant Engineer, January, 1909. In this Department he was in charge of a party on surveys, construction work and surveys for the Jamaica Bay Improvement.

In February, 1899, he married Miss Nettie Service, of Hamilton, Ohio, who survives him.

FREDERICK DREWS.†

Frederick Drews was born in Zarnewenz, Mecklenburg, Germany, on February 17th, 1855. He graduated from St. Catharine's College, Luebeck, Germany, and studied four years at the Polytechnicum of Berlin, after which he was employed in an architect's office in Germany. From 1885 to 1886 he assisted in the technical management of sugar manufactories in Porto Rico. From 1886 to 1891 he was severally employed, as draftsman for Hepworth & Co., on machinery for sugar refineries in Yonkers, N. Y.; for Mr.

* Memoir prepared by Edward P. Herrmann, M. M. E. N. Y.

† Memoir prepared by G. L. Christian, M. M. E. N. Y.

Engelhardt, a Brooklyn architect; for the De La Vergne Refrigerating Co., New York City. From October 15th, 1891, until the day of his death he was employed in the Borough of The Bronx: first in the Topographical Bureau, and subsequent to August, 1903, in the Bureau of Sewers, as a computer. He was a conscientious, careful workman; quiet, unassuming; had a broad and liberal education, and was a perfect gentleman. He never married. He was elected a member of the Municipal Engineers of the City of New York September 27th, 1911. He died September 27th, 1912. A sister, residing in Germany, survives him.

JOHN M. STEINMETZ *

John M. Steinmetz was born November 23d, 1872, in New York City; died October 19th, 1912. His early life was spent at Boston, Mass., where he received his elementary education at the private and public schools, the study of engineering being taken up in the year 1894, upon his entrance as an assistant in the office of a mechanical engineer at Boston, Mass. At the end of two years he became engaged in the contracting business, under Mr. W. J. Kelly, Civil Engineer, on General Road and Highway Bridge Construction in New Hampshire. In the year 1902 he came to New York and joined the Engineering Staff of the Central Railroad of New Jersey as Transitman, in charge of Dock and General Water Front Construction, remaining with the Central Railroad until his appointment as Rodman, in the year 1904, with the old Rapid Transit Railroad Commission (now Public Service Commission, First District, N. Y.); six months later he was appointed Assistant Engineer and assigned in charge of Section 2-A, 5th Division, being in responsible charge of alignment work of the East River Tunnels from the Battery to Brooklyn. While engaged on this work he had a severe attack of the "Bends" (caisson disease), which completely undermined his former vigorous health, and from which he never fully recovered. Until May, 1912, the time of his last illness, he was in charge of construction on a section of the Fourth Avenue Subway, Brooklyn. At the time of his death he was Vice-President of the Brooklyn Engineers' Club.

* Memoir prepared by William F. Steinmetz, M. M. E. N. Y.

HERMAN ARNOLD RUGE.*

Herman Arnold Ruge, charter member of the Municipal Engineers, died suddenly at Cranberry Lake, N. J., on April 6th, 1912, while actively engaged in making ready his summer camp for the coming season.

He was born in Dresden, Germany, on the 24th of August, 1843, being the youngest son of Dr. Arnold Ruge, a prominent scholar. author and journalist of his time.

Mr. Ruge received his education in the schools of Dresden, whence he went to Zurich, Switzerland, taking the degre of C. E. at the Polytheclinic Institute there. He finished his studies by post-graduate work in Karlsruhe.

He was engaged from 1867 to 1869 as Assistant Engineer with the London, Brighton and South Coast Railway, in England, on design and construction of bridges. Later in charge of the construction of the Edenbridge Tunnel in Kent.

1870, took first prize in public competition for "Childs Hill Drainage Works," Hempstead, in London, and superintended construction.

Later, in a similar competition, his plans and design were accepted for a drainage and waterworks system for the Town and Harbor of Littlehampton, Sussex, England.

He designed and constructed for the Calcutta Waterworks, East India (Messrs. Brassey, Wythes & Aird, Contractors), the Barrakpoore Bridge, Crossing a branch of the Ganges River; designed a swing bridge and several others for the company of the Bristol Harbor Improvements, England, also the "Blackwater River Viaduct" in Worcestershire, England.

From 1871 to 1876 he was engaged as Constructing Engineer by the East Hungarian Railway Company on two divisions of heavy works through the Karpathian Mountains. On the completion of this railway, Mr. Ruge made his home in Zurich, Switzerland. Here he designed and constructed the well-known hydraulic cable railway.

Mr. Ruge was one of the pioneers in the development of the extensive use of concrete construction. For ten years, in Zurich, he

*Memoir prepared by Bernard A. Ruge M. M. E. N. Y.

manufactured cement bricks and concrete blocks for general building construction.

1887-8, Chief Engineer on design and location of the Siehl Valley Railway Project, from Zurich to the St. Gotthard Railway.

In 1889 he was chosen by the Society of Civil Engineers in Switzerland to serve as delegate to the Swiss Government for considering the best method to meet the difficulty of the so-called "blowing section" in the St. Gotthard Tunnel.

In the same year Mr. Ruge was appointed as expert for the "Disconto Bank" and the "Norddeutsche Bank" of Berlin to go to Venezuela, South America, for the purpose of reporting and estimating on the cost of construction of the "Great Venezuelan Railway" from Caracas to Valencia, *via* Los Teques and La Victoria. Later, he took the contract for the construction of 50 miles of this railway and acted as Consulting Engineer for the contractors building the other sections.

In connection with the latter project, Mr. Ruge met with financial reverses. At its completion he came to New York early in 1890 and began anew. He was engaged for some time with the Brooklyn City Railroad on construction work and power-house design.

In 1894 he entered the City service and served in the Tax Department, the Department of Water Supply and finally with the Department of Docks and Ferries, where he was engaged in the designs for the Chelsea and other improvements.

During his life in New York Mr. Ruge was active in the consideration of plans for the City's development. His chief project, which he conceived in 1893, and was published at that time and presented to the then Mayor Gilroy, was the extension of Manhattan Island by a connection with Governors Island and an extension of the latter into the bay. The last feature was carried out by the Federal Government. Mr. Ruge's project is covered in detail in a paper which he read before the Society.

Mr. Ruge's life was unselfish and full of buoyant hope, in spite of difficulties. He was possessed of a peculiar power to make lasting friends and was known to be ever ready with an appropriate anecdote.

He is survived by his wife, a daughter and son, the latter a member of this Society.

STEPHEN EUGENE MEAGHER.*

Stephen Eugene Meagher, an organizer, charter member and active worker of the Municipal Engineers, died at his home in New York City, August 31st, 1912. He was born in the Old Greenwich Village Section of New York City, November 18th, 1871, and was educated at St. Anthony's Parochial School, New York Evening High School and Cooper Union Night School of Science, from which he graduated in 1898, and received the degree of Civil Engineer in 1907. He was engaged in business as a florist and landscape gardner about ten years prior to August, 1900, when he was appointed as an Axeman by the Rapid Transit Railroad Commission and assigned to duty with the Second Division under Mr. Alfred Craven. In September, 1901, he was promoted to Rodman; he assisted on survey work and later was put in charge of the force account. In August, 1904, he was transferred to the Department of Docks and Ferries as Leveler; August, 1906, promoted to Transitman and Computer, and in January, 1909, became an Assistant Engineer. Mr. Meagher was assigned to the Dredging Bureau of this Department and among other operations was connected with the extensive improvements for the Chelsea Section in Manhattan and the Gowanus Section in South Brooklyn; he also was connected with the paving done by this department, and before his death was in charge of both these classes of work.

Mr. Meagher was a robust, kindly, good natured man and his demise was mourned by a host of friends he had made in the Profession. He was a member of the Royal Arcanum, the Cooper Union Alumni Association, in which he took an active interest, and attended the Roman Catholic Church of Our Lady of Lourds, New York City. Mr. Meagher was a single man; a widowed mother, two brothers and three sisters, with whom he lived, survive him.

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* Memoir prepared by Edward P. Herrmann, M. M. E. N. Y.

HENRY GECKS.*

Henry Gecks was born in New York City on November [illegible], [illegible], and died in the same city on May [illegible], [illegible]. He was educated in the [illegible] of the City of New York, after which, in August, [illegible], he entered the engineering service of the City of New York. He was later employed as a Leveler in the Bureau of Sewers, Borough of The Bronx, from which he was transferred to a similar position in the Department of Parks in the same borough, where he was employed at the time of his death. He was a charter member of the Municipal Engineers of the City of New York. He was of a retiring disposition, unmarried, and made his home with his sister at No. [illegible] Eagle Avenue, Borough of The Bronx.

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*Memoir prepared by [illegible], M. E. [illegible] N. Y.

INFORMATION.

MEETINGS.—Regular meetings are held in the Engineering Societies Building, No. 29 West 39th Street, Manhattan, on the fourth Wednesday of each month at 8:30 P. M., except in June, July and August. The Annual Meeting is held on the fourth Wednesday in January.

LIBRARY.—The Society rooms and library are open every day and evening, including Sundays and holidays. Keys may be obtained from the Secretary on the deposit of 25 cents each.

Members of the Society and all who feel an interest in the maintenance of a technical reference library, devoted more especially to the subject of municipal engineering, are asked to donate engineering books, reports, specifications, maps, plans and photographs.

PROCEEDINGS.—The Society issues one volume of PROCEEDINGS each year, usually in May. It contains all of the papers presented during the preceding year, the annual address of the President, the final reports of special committees on professional subjects, descriptions of the works visited by the Society, and the speeches delivered at the annual banquet, which are of permanent value.

Proceedings are furnished without extra charge to members, and are sold for $2.00 in cloth and $1.50 in paper. Exchanges are desired with other societies, libraries, colleges, etc.

PAPERS.—Papers and discussions on subjects of engineering interest are invited from all persons, whether members of the Society or not. They are, of course, subject to proper editorial supervision. All papers on their acceptance become the property of the Society.

BADGES.—The badge of the Society is of gold with blue enamel in the design shown on the title page of this book. It has a number engraved upon the back, and may be obtained as a pin, a watch charm, or a button. The price is $4.00. Application for it should be made to the Secretary.

CERTIFICATES OF MEMBERSHIP.—The certificate of membership is steel-engraved on parchment paper, engrossed with the name of the member and the date of his election; the seal of the Society is impressed, and it is signed by the President and the Secretary. The size is 14 by 18 inches, and the price is $2.00. Application for it should be made to the Secretary.

DUES.—The dues for Resident Membership are $10.00 a year, for Non-resident Membership, $5.00 a year.

REMITTANCES.—All remittances should be made payable to the order of Municipal Engineers. They should be made by check on New York or by post-office or express money order payable at New York.

ABBREVIATION FOR MEMBER.—The Board of Directors has authorized the use of the abbreviation "M. M. E. N. Y.," to signify "Member of the Municipal Engineers of the City of New York."

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Term Expires January, 1914

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Term Expires January, 1915

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PAST AND PRESENT OFFICERS

[illegible]

PRESIDENTS

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FIRST VICE-PRESIDENTS

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SECOND VICE-PRESIDENTS

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[illegible]	[illegible]
Anna L. Schaeffer	1913

SECRETARIES

[illegible] Martin	1903-4-5-6
Clarence D. Wallick	1907-8-9-10-11
[illegible] A. Taber	1912-13

TREASURERS

Arthur S. Tuttle	1903-4-5-6-7
Henry W. Vogel	1908-9
Herman K. Endemann	1910-11-12-13

DIRECTORS

[illegible] Hering	1903
Robert Ridgway	1903-4-5
*William S. Dalrymple	1903-4

* Deceased.

ROBERT R. CROWELL	1903-4-5-6
FREDERICK SKENE	1903
GEORGE S. RICE	1903-4-5
MAX RAYMOND	1903-4
HENRY R. ASSERSON	1903-4-5-6-7
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EDWARD A. MILLER	1903-4-5-11-12-13
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LLEWELLYN W. FREEMAN	1905-6-7
ANDREW J. PROVOST, Jr	1905-6
ELMORE F. AUSTEN	1905-6
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WILLIAM R. HILLYER	1906-7-8
EDWARD L. HARTMANN	1906-7-8
GEORGE R. OLNEY	1906-7-8
CLARENCE D. POLLOCK	1906
WILLIAM D. LINTZ	1907-8
ALBERTO SCHREINER	1907-8-9
FREDERICK C. NOBLE	1907-8-9-12
CORNELIUS V. V. POWERS	1907-8-9
DANIEL D. JACKSON	1907-8-9
EDWARD H. HOLDEN	1907-8-9-10
GEORGE W. TUTTLE	1908-9-10
GEORGE A. TABER	1908-9-10
EDMUND J. MAURER	1908-9-10
EDWIN J. FORT	1908-9-10-11-12-13
GEORGE L. CHRISTIAN	1909-10-11-13-14-15
JOHN T. FETHERSTON	1909-10-11
GEORGE R. FERGUSON	1909-10-11
ALFRED D. FLINN	1909-10-11
JOHN H. WEINBERGER	1909-10-11
EDWARD P. HERRMANN	1910-11-12
WILLIAM F. LAASE	1910-11-12
F. X. A. PURCELL	1910-11
WINFRED H. ROBERTS	1910-11-12-13-14-15
GARDNER L. VAN DUSEN	1910-11-12
AMOS L. SCHAEFFER	1911-12
EDWARD M. LAW, Jr	1911-12-13
DANIEL L. TURNER	1911-12-13
NOAH CUMMINGS	1912-13-14
FRANK E. WINSOR	1912-13-14
WILLIAM W. BRUSH	1912-13-14
JOHN P. BINZEN, Jr	1912-13-14
J. WALDO SMITH	1912-13-14
EDWARD P. RAMSEY	1913-14-15
ABRAHAM LODHOLZ	1913-14-15
JOHN F. SULLIVAN	1913-14-15
ROBERT A. WIMMER	1913

AWARD OF PRIZES.

These papers will be found in Proceedings for the years indicated.

1903.

JAMES COPPER BAYLES, M. M. E. N. Y., for paper entitled: The Problem of the Maintenance of Asphalt Pavements in Manhattan.

1904.

GEORGE WILLIAM TILLSON, M. M. E. N. Y., for paper entitled: The Maintenance and Repairs of Asphalt Pavements.

1905.

SIDNEY WILLETT HOAG, Jr., M. M. E. N. Y., for paper entitled: The Dock Department and the New York Docks.

1906.

ALFRED DOUGLAS FLINN, M. M. E. N. Y., for paper entitled: The Organization of an Engineering Force in New York City.

1907.

EDWARD H. HOLDEN, M. M. E. N. Y., for paper entitled: Traverse Work in Connection with the Triangulation of the Borough of The Bronx.

1908.

ROBERT RIDGWAY, M. M. E. N. Y., for paper entitled: Subsurface Investigations of the Board of Water Supply for the Proposed Catskill and Long Island Aqueducts and Reservoirs, Northern Aqueduct Department.

1909.

THOMAS H. WIGGIN, M. M. E. N. Y., for paper entitled: The Design of Pressure Tunnels of the Catskill Aqueduct.

1910.

FREDERICK SCOTT COOK, M. M. E. N. Y., for paper entitled: The Construction of the Croton Falls Reservoir of the New York City Water Supply.

1911.

VERNON STANLEY MOON, M. M. E. N. Y., for paper entitled: A Proposed Method of Interpreting the Elevations of All Portions of a Street Surface from Established Grades.

PAST PRESIDENTS' MEDALS.

NELSON PETER LEWIS	[illegible]
SAMUEL CLARENCE THOMPSON	[illegible]
GEORGE WILLIAM TILLSON	[illegible]
GEORGE STAPLES RICE	[illegible]
ROBERT RIDGWAY	[illegible]
ROBERT REYNOLDS CROWELL	[illegible]
ARTHUR SMITH TUTTLE	[illegible]
HENRY WILLIAM VOGEL	1911
SIDNEY WILLETT HOAG, Jr.	1912

INDEX TO PREVIOUS VOLUMES.

PROCEEDINGS FOR 1903.

PAGE

Paper No. 1.—Park Engineering in the Boroughs of Manhattan and the Bronx, By Nelson P. Lewis, M. M. E. N. Y. 7

Paper No. 2.—The Old Roman Aqueducts, By Edward Wegmann, M. M. E. N. Y. 26

Paper No. 3.—Rapid Transit in New York City, By George S. Rice, M. M. E. N. Y. 62

Paper No. 4.—Some Street Traffic Problems, By Wisner Martin, M. M. E. N. Y. 74

Paper No. 5.—The Problem of the Maintenance of Asphalt Pavements in Manhattan,* By James C. Bayles, M. M. E. N. Y. 80

Paper No. 6.—The Investigation of Sources of Water Supply in the City of New York, Topical Discussion by A. S. Tuttle, M. M. E. N. Y.; W. W. Brush, M. M. E. N. Y., and D. D. Jackson, M. M. E. N. Y. 100

PROCEEDINGS FOR 1904.

Paper No. 7.—Investigation for the New Water Supply of the City of New York, By William H. Burr, M. M. E. N. Y. 5

Paper No. 8.—The Maintenance and Repairs of Asphalt Pavement,* By George W. Tillson, M. M. E. N. Y. 20

Paper No. 9.—The Construction of Public School Buildings in the City of New York, By C. B. J. Snyder, M. M. E. N. Y. 46

Paper No. 10.—Harlem River Bridges, By Martin Gay, M. M. E. N. Y. 67

Paper No. 11.—The History and Development of the Topographical Work of the City of New York, By Frederick Greiffenberg, M. M. E. N. Y., and William S. Dalrymple 83

Paper No. 12.—Plans and Specifications, By J. V. Davies .. 105

Paper No. 13.—Subaqueous Water Mains, By William D. Lintz, M. M. E. N. Y. 130

Paper No. 14.—Chemical Precipitation Plans, Contact Beds and Septic Tanks as Considered in a Design for a Portion of Brooklyn's Sewers, By Henry R. Asserson, M. M. E. N. Y. 155

* Prize paper.

PROCEEDINGS FOR 1905.

PAGE

PAPER No. 15.—THE NEW CROTON AQUEDUCT. BY EDWARD WEGMANN, M. M. E. N. Y., EXPERT ENGINEER, AQUEDUCT COMMISSIONERS.. [illegible]

PAPER No. 16.—THE DOCK DEPARTMENT AND THE NEW YORK DOCKS.* BY SIDNEY W. HOAG, JR., M. M. E. N. Y., ASSISTANT ENGINEER, DEPARTMENT OF DOCKS AND FERRIES.. [illegible]

PAPER No. 17.—THE ENGINEER'S [illegible]. BY JOHN C. WAIT, M. M. E. N. Y., COUNSELLOR AT LAW.................... [illegible]

PAPER No. 18.—REPORT OF THE SPECIAL COMMITTEE ON DATUM PLANES. BY LAZARUS WHITE, M. M. E. N. Y., ASSISTANT ENGINEER, RAPID TRANSIT COMMISSIONERS............... [illegible]

PAPER No. 19.—THE DESIRABILITY OF COMPREHENSIVE MUNICIPAL PLANNING IN ADVANCE OF DEVELOPMENT. BY CALVIN TOMPKINS, FORMER PRESIDENT OF THE MUNICIPAL ART SOCIETY.. [illegible]

PAPER No. 20.—THE PROPOSED MUNICIPAL LIGHTING PLANT. BY GEORGE F. SEVER, M. M. E. N. Y., CONSULTING ELECTRICAL ENGINEER, DEPARTMENT OF WATER SUPPLY, GAS AND ELECTRICITY, AND MEMBER OF THE MAYOR'S COMMITTEE OF EXPERTS.................................. [illegible]

PAPER No. 21.—HISTORY AND DEVELOPMENT OF THE PLANE TABLE. BY EDWARD M. LAW, JR., M. M. E. N. Y., ASSISTANT ENGINEER, OFFICE OF THE BOROUGH PRESIDENT OF RICHMOND.. 25[illegible]

REPORT OF THE SPECIAL COMMITTEE ON COST OF REPAIRS TO ASPHALT PAVEMENTS, GEORGE W. TILLSON, M. M. E. N. Y., CHAIRMAN .... 27[illegible]

PROCEEDINGS FOR 1906.

PAPER No. 22.—THE SUBSTRUCTURE OF THE HOUSATONIC RIVER BRIDGE AT NAUGATUCK JUNCTION, CONN., BY CAMILLE MAZEAU, ASSISTANT ENGINEER, NEW YORK, NEW HAVEN AND HARTFORD RAILROAD................................ 5

PAPER No. 23.—THE MANHATTAN BRIDGE, ITS TERMINALS AND CONNECTIONS, BY OTHNIEL F. NICHOLS, M. M. E. N. Y., CONSULTING ENGINEER, DEPARTMENT OF BRIDGES.......... 16

PAPER No. 24.—THE TESTING OF MATERIAL BY THE BUREAU OF BUILDINGS FOR MANHATTAN, BY RUDOLPH P. MILLER, M. M. E. N. Y., ASSISTANT ENGINEER, BUREAU OF BUILDINGS, MANHATTAN....................... 41

PAPER No. 25.—RECENT DEVELOPMENTS IN WOOD BLOCK PAVING, BY FREDERICK A. KUMMER, ENGINEER, UNITED STATES WOOD PRESERVING COMPANY............................ 5[illegible]

* Prize paper.

PAGE

Paper No. 26.—The High Pressure Fire Service in Manhattan, By Ignacio M. de Varona, M. M. E. N. Y., Chief Engineer, Department of Water Supply, Gas and Electricity 83

Paper No. 27.—The Organization of an Engineering Force in New York City,* By Alfred D. Flinn, M. M. E. N. Y., Department Engineer, Board of Water Supply.... 21

Paper No. 28.—Foundations for Skyscrapers, By John W. Doty, Engineer, Foundation Company................. 140

Paper No. 29.—Tunnelling Under Compressed Air with Shields, By St. John Clarke, M. M. E. N. Y., Chief Engineer, New York and Long Island Railroad Company 157

PROCEEDINGS FOR 1907.

Paper No. 30.—Construction Details of Reinforced Concrete Work, By De Forest H. Dixon, Secretary, Turner Construction Company.......................... 5

Paper No. 31.—The Geology of Long Island and Its Practical Relation to Underground Water Supplies, By Alexander Simpson Farmer, M. M. E. N. Y., Assistant Engineer, Aqueduct Commissioners.................. 21

Paper No. 32.—Some Notes on Municipal Cleaning and Refuse Destruction, By John Turney Fetherston, M. M. E. N. Y., Superintendent of Street Cleaning, Borough of Richmond.................................. 47

Paper No. 33.—The Relation of Sanitary Science to Municipal Engineering, By George A. Soper, M. M. E. N. Y., Consulting Sanitary Expert, Public Service Commission... 70

Paper No. 34.—Traverse Work in Connection With the Triangulation of the Bronx Borough,* By Edward H. Holden, M. M. E. N. Y., Assistant Engineer in Charge of Surveys and Monumenting, Topographical Bureau, Borough of the Bronx..................... 81

Paper No. 35.—The Desirability of Centralized Engineering Control for New York City, By M. N. Baker, Editor, Engineering News.............................. 104

Paper No. 36.—The Southerly Extension of New York City, By Herman Arnold Ruge, M. M. E. N. Y., of the Department of Docks and Ferries.................... 121

Paper No. 37.—The Designing, Making and Testing of a Telescope, By F. Kollmorgen, Optical Expert, Keuffel & Esser Company.................................. 134

* Prize paper.

PROCEEDINGS FOR 1908.

	PAGE
PAPER NO. 38.—THE PROPOSED FILTRATION OF THE CROTON WATER SUPPLY OF NEW YORK CITY, BY WILLIAM B. FULLER, M. M. E. N. Y., CONSULTING CIVIL ENGINEER....	4
PAPER NO. 39.—SUBSURFACE INVESTIGATIONS OF THE BOARD OF WATER SUPPLY FOR THE PROPOSED CATSKILL AND LONG ISLAND AQUEDUCT AND RESERVOIRS,* BY DWIGHT S. MALLETT, M. M. E. N. Y.; ROBERT RIDGWAY, M. M. E. N. Y.; WILSON FITCH SMITH, AND WALTER E. SPEAR, M. M. E. N. Y., ENGINEERS OF THE BOARD OF WATER SUPPLY....................................	31
PAPER NO. 40.—THE POSSIBILITIES OF THE ESTHETIC DEVELOPMENT OF OUR CITY, BY CHARLES ROLLINSON LAMB, ARCHITECT....................................	87
PAPER NO. 41.—THE SEWERAGE PROBLEM OF THE BOROUGH OF QUEENS, BY ALBERTO SCHREINER, M. M. E. N. Y., ASSISTANT ENGINEER, BUREAU OF SEWERS, BOROUGH OF QUEENS..	115
PAPER NO. 42.—BENCH LEVELS AND NEW YORK CITY DATUMS, BY CHARLES GOODMAN, M. M. E. N. Y., ASSISTANT ENGINEER, BOARD OF WATER SUPPLY......................	130
PAPER NO. 43.—MUNICIPAL WATER-WORKS OF THE FAR EAST, BY GEORGE A. JOHNSON, OF FIRM OF HERING & FULLER, CONSULTING ENGINEERS..............................	183
PAPER NO. 44.—WATERPROOFING—AN ENGINEERING PROBLEM, BY MYRON H. LEWIS, M. M. E. N. Y., ASSISTANT ENGINEER, TOPOGRAPHICAL BUREAU, BOROUGH OF QUEENS....	208
PAPER NO. 45.—THE ST. GEORGE FERRY APPROACH AND REINFORCED CONCRETE RETAINING WALL, BY LOUIS L. TRIBUS, M. M. E. N. Y., COMMISSIONER OF PUBLIC WORKS AND CONSULTING ENGINEER, BOROUGH OF RICHMOND..........	261
APPENDIX TO PAPER NO. 34.—NEW INSTRUMENTS FOR PRIMARY TRAVERSE WORK, BY EDWARD H. HOLDEN, M. M. E. N. Y., ASSISTANT ENGINEER IN CHARGE OF SURVEYS AND MONUMENTING, TOPOGRAPHICAL BUREAU, BOROUGH OF THE BRONX....................................	278

PROCEEDINGS FOR 1909.

PAPER NO. 46.—AN ADDITIVE METHOD OF RUN-OFF DETERMINATION FOR STORM-WATER SEWERS, BY CARL H. NORDELL, M. M. E. N. Y., BUREAU OF SEWERS, BOROUGH OF QUEENS.	5
PAPER NO. 47.—SOME INTERESTING AMERICAN TREES, BY HERMAN W. MERKEL, CHIEF FORESTER, NEW YORK ZOOLOGICAL PARK....................................	36

* Prize paper, portion by Mr. Robert Ridgway.

PAGE

Paper No. 48.—Improvements of the Appearance of Municipalities, By Charles W. Leavitt, Jr., Landscape Engineer, New York City 53

Paper No. 49.—The Sanitary Protection of Water Supplies, By Nicholas S. Hill, Jr., M. M. E. N. Y., Consulting Engineer, New York City 64

Paper No. 50.—Construction Problems of the Brooklyn Subway, By James C. Meem, Chief Engineer, Cranford & McNamee 91

Paper No. 51.—The Design of Pressure Tunnels of the Catskill Aqueduct,* By Thomas H. Wiggin, M. M. E. N. Y., Senior Designing Engineer, Board of Water Supply 99

Paper No. 52.—The New York State Barge Canal, By Frederick Skene, M. M. E. N. Y., Consulting Engineer, New York City 150

Paper No. 53.—The Reduction of the Water Table and Its Effect on Foundations in New York City, By Francis L. Pruyn, Vice-President of the Underpinning Co., and Consulting Engineer, New York City 161

PROCEEDINGS FOR 1910.

Paper No. 54.—The Henry Hudson Memorial Bridge, By William H. Burr, M. M. E. N. Y., Consulting Engineer, Department of Bridges 5

Paper No. 55.—The Manhattan Bridge, By Alexander Johnson, M. M. E. N. Y., Chief Engineer, Department of Bridges 21

Paper No. 56.—The Development of Jamaica Bay Into a Harbor for New York City, By William G. Ford, M. M. E. N. Y., Consulting Engineer, and Member of the Jamaica Bay Improvement Commission 42

Paper No. 57.—Economic Aspects of City Planning, By Benjamin C. Marsh, Secretary Committee on Congestion of Population in New York City 73

Paper No. 58.—Studies and Explorations for the Hudson River Crossing of the Catskill Aqueduct, By Samuel D. Dodge and William B. Hoke, Assistant Engineers, Board of Water Supply 99

Paper No. 59.—The Street Pavement Problem in the Borough of Manhattan, By George W. Tillson, M. M. E. N. Y., Chief Engineer, Bureau of Highways 136

* Prize paper.

PAGE

Paper No. 60.—Some Problems in Sewage Disposal of New York, By William M. Black, Colonel, Corps of Engineers, United States Army 164
Paper No. 61.—Construction of the Croton Falls Reservoir, New York City Water Supply,* By Frederick S. Cook, M. M. E. N. Y., Division Engineer, Department of Water Supply, Gas and Electricity 224

PROCEEDINGS FOR 1911.

Paper No. 62.—The Geology of New York City in Its Relation to Engineering Problems. By Charles P. Berkey, M. M. E. N. Y., Professor of Geology, Columbia University, and John R. Healy, M. M. E. N. Y., Assistant Engineer, Board of Water Supply 5
Paper No. 63.—A Proposed Method of Interpreting the Ele--vations of All Portions of a Street Surface from the Established Grades,* By Vernon S. Moon, M. M. E. N. Y., Assistant Engineer, Board of Estimate and Apportionment 40
Paper No. 64.—Sanitary Problems of the Board of Water Supply, By Andrew J. Provost, Jr., M. M. E. N. Y., Sanitary Expert, Board of Water Supply 77
Paper No. 65.—Construction of the Rondout Pressure Tunnel of the Catskill Aqueduct, By Lazarus White, M. M. E. N. Y., Division Engineer, Board of Water Supply 98
Paper No. 66.—The City Plan, and What It Means, By Nelson P. Lewis, M. M. E. N. Y., Chief Engineer Board of Estimate and Apportionment 146
Paper No. 67.—The Contractor's View of City Contracts and Specifications, By C. A. Crane, M. M. E. N. Y., Secretary General Contractors' Association, New York City 179
Paper No. 68.—The Port of New York, By Calvin Tomkins, Commissioner of Docks and Ferries, City of New York.. 222
Paper No. 69.—Some Observations in Regard to Water-Works Pumping Stations, By Nicholas S. Hill, Jr., M. M. E. N. Y., Consulting Engineer, New York City.. 235

* Prize paper.

INDEX TO ADVERTISEMENTS.

	PAGE
American Asphaltum & Rubber Co...	7
American Iron & Steel Mfg. Co........	15
American Pipe & Construction Co....	49
Atlas Portland Cement Co............	40
Barber Asphalt Paving Co............	3
Barrett Manufacturing Co............	5
Bausch & Lomb Optical Co...........	37
Booth Bros. & Hurricane Isle Granite Co..........................	19
Brown Hoisting Machinery Co....	25
Builders Iron Foundry................	49
Burke & Sons Co., Inc., Luke A......	45
Cameron Steam Pump Works, A. S..	24
Case Threshing Machine Co., Inc., J. I.	27
Champion Blower & Forge Co.........	15
Chapman Valve Mfg. Co...............	23
Clark, Watson G.......................	48
Clyde Iron Works.....................	31
Coldwell-Wilcox Co...................	22
Destructor Co..........................	42
Dietzgen Co., Eugene....................	38
Dunn Wire-Cut-Lug Brick Co........	7
Eddy & Co., George M................	36
Engineering Record...................	34
Evening Post Job Printing Office.....	46
Fitzgerald, W. J.......................	44
Fox & Co., John.......................	41
Good Roads Machinery Co., Inc.......	27
Greene, Tweed & Co..................	16
Hanna Mfg. Co.........................	37
Harlem Contracting Co...............	10
Hastings Pavement Co................	11
Hayward Co...........................	28
Higgins & Co., Inc., Chas. M..........	36
Holt Caterpillar Co....................	26
Insley Mfg. Co.....	29
Iroquois Iron Works..................	26
Johns-Manville Co., H. W.............	13
Johnson's Sons, Joseph...............	18
Keasbey Co., Robert A................	32
Keuffel & Esser Co....................	38
Lehigh Portland Cement Co..........	39
Leschen & Sons Rope Co., A.........	32
Lidgerwood Manufacturing Co........	28
Lima Locomotive Corporation........	14
Lock Joint Pipe Co.....................	21
Lufkin Rule Co........................	49
Luitwieler Pumping Engine Co........	23
Millar & Son Co., Charles..............	20
Morris Machine Works.................	24
Morse Twist Drill & Machine Co......	16
Mundy's Engine Works, J. S.........	31
New York Steam Co.................	48
Norwood Engineering Co.............	22
Oil Well Supply Co.....................	25
Patton Clay Manufacturing Co.......	9
Pease Co., C. F...................... ...	35
Pennsylvania Cement Co..............	40
Phœnix Sand and Gravel Co.........	19
Rail Joint Co...........................	47
Remington Typewriter Co............	12
Riter-Conley Mfg. Co..................	29
Robins Conveying Belt Co.............	2
Rockport Granite Co..................	8
Rodgers & Hagerty, Inc................	43
Roebling's Sons Co., John A..........	38
Royal Typewriter Co..................	34
Schrader's Son, Inc., A................	49
Smith Manufacturing Co., A. P.......	20
Standard Oil Co. of N. Y..............	6
Sterling Engraving Co................	48
Stewart Heater Co....................	14
Toch Bros.............................	18
Union Clay Products Co...............	18
Union Iron Works.....................	30
United States Wood Preserving Co..	4
United Gas Improvement Co...........	2
Wallace Supply Co.....................	17
Wyckoff Pipe & Creosoting Co., Inc...	3
Wyoming Shovel Works...............	17
Yawman & Erbe Manufacturing Co...	35

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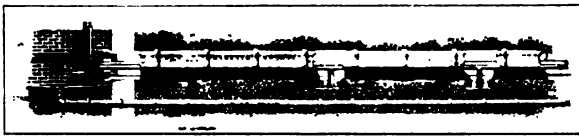

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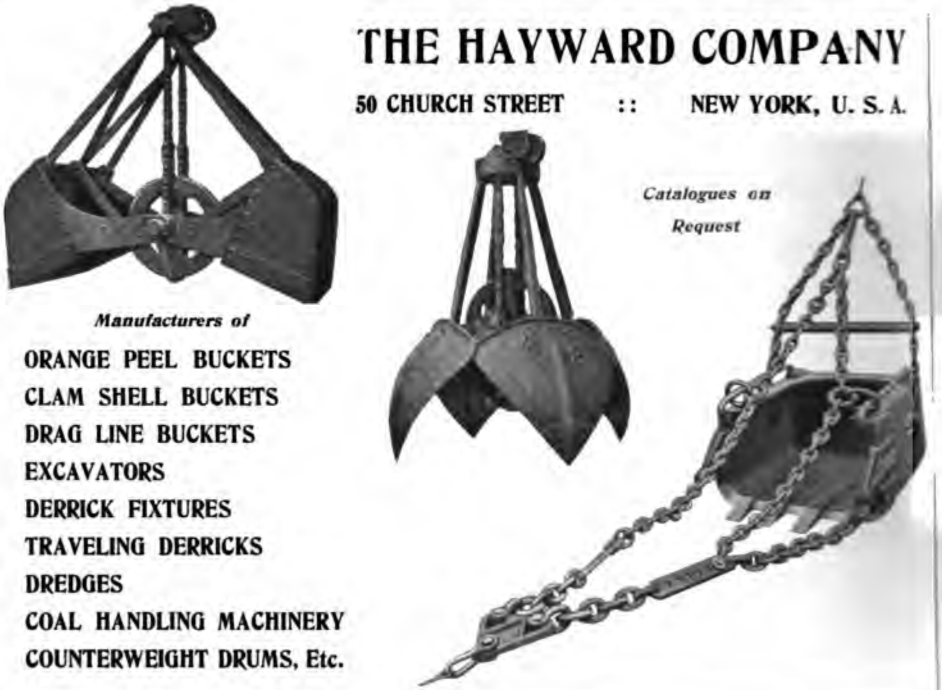

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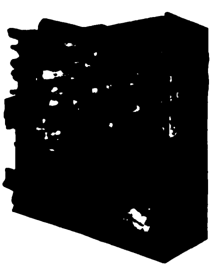

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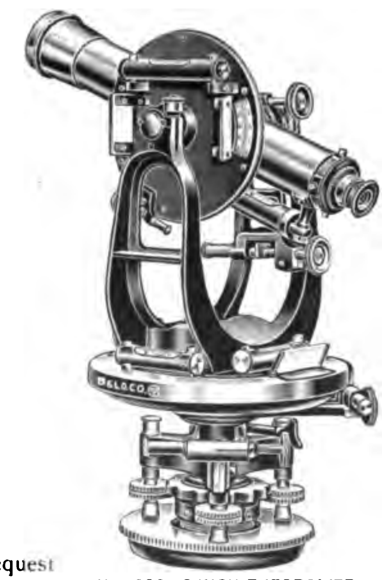

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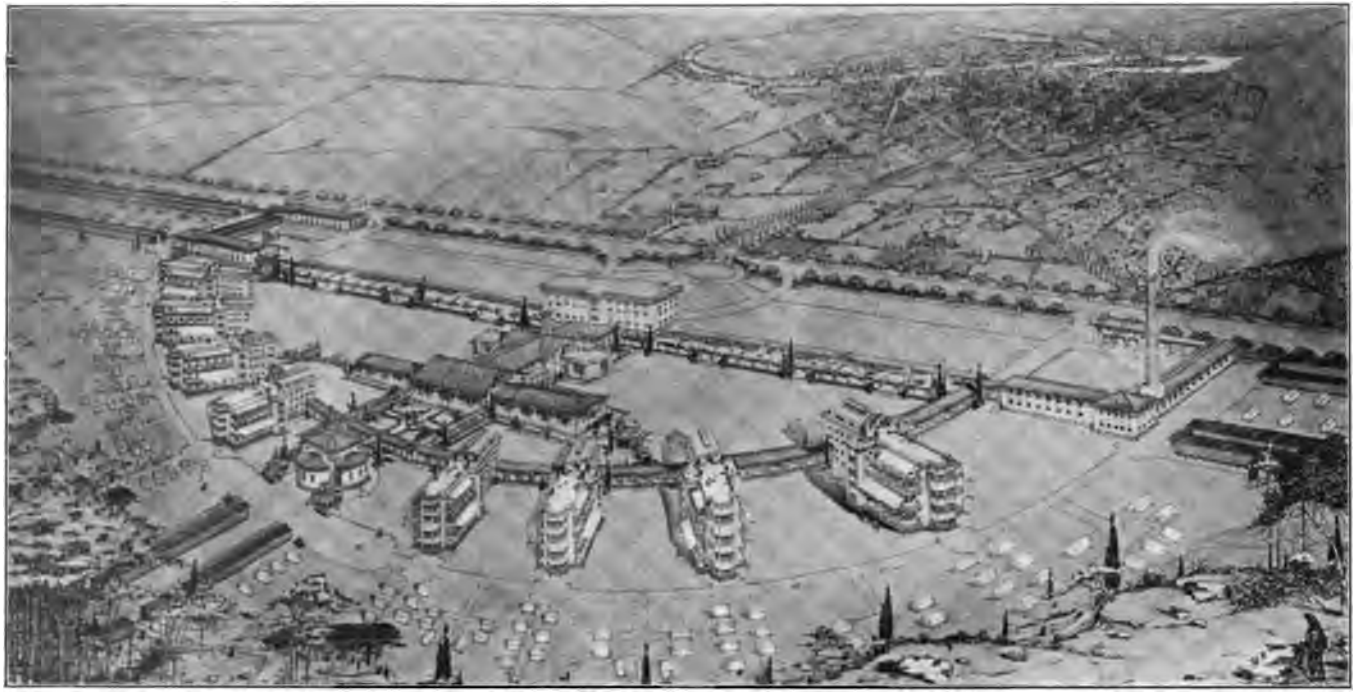

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